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ABSTRACT

This publication was designed to provide assistance to California school personnel and architects in the design of new science facilities. Following the introduction, chapter 1 discusses the enhancement of science programs through architectural design. Chapter 2 describes architectural requirements and regulations for science-instruction facilities in California, and the third chapter outlines steps in the planning process. The next three chapters offer guidelines for elementary-, middle-, and high-school science facilities. Planning the science complex from site development to occupancy is described in chapter 7, and requirements for furnishings and appliances are delineated in chapter 8. Cost estimates are provided in the final chapter. Forty-nine figures are included. Appendices contain checklists for the total science complex, the laboratory/classroom, and the science preparation/storage area. (LMI)

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INTRODUCTION

School districts in California must build, furnish, and equip science classrooms with facilities to accommodate instructional programs with significant student laboratory components. Recommendations for activity-based lessons and increased enrollments in science courses support the need for these facilities. The *Science Framework for California Public Schools* (1990) specifies the following:

- "Of the total time spent learning science, at least 40 percent should be in activity-based lessons."[1] This concept applies to science programs in kindergarten through grade twelve.
- "Both college- and employment-bound students should take science courses beyond the state-mandated two years. . . ."[2]

Given these guidelines, California educators will increase the amount of laboratory experience for students in kindergarten through grade twelve and the use of science laboratories. This trend indicates a greater need for science classrooms as well as for improved flexibility in classroom design at all grade levels. Naturally, demands for storage for equipment as well as storage for supplies and student projects also will increase.

The purpose of this publication is to provide assistance to school personnel and architects in the design of new science facilities. The principles presented may prove useful for planning facilities to be used for programs other than science; however, science facilities receive primary attention. Separate facilities specifically designed for science have not typically been included in elementary schools—a trend likely to be reversed in the 1990s. Those planning science facilities for middle schools, junior high schools, and senior high schools will find the content more useful than will planners at the elementary level. However, a brief section on facilities for elementary school science is included. In any case, the principles of design for secondary schools also apply to those for elementary schools either in planning separate science facilities or in enhancing the regular classrooms for science instruction.

This publication will focus on the basic design of flexible science facilities that will accommodate a typical pattern for science instruction whereby *a class of students is assigned for daily instruction to one teacher in a laboratory/classroom for one class period.* The design of schools to accommodate extensive and complex uses of instructional innovations, such as team teaching, individualized instruction, and lectures for large groups and labora-

"Both college- and employment-bound students should take science courses beyond the state-mandated two years. . . ."

Science Framework for California Public Schools, 1990, p. 160

". . . everyday materials and laboratory equipment, videotapes and software, and other printed materials such as reference books provide a substantial part of student experience."

Science Framework for California Public Schools, 1990, p. 9.

tories for small groups will not be ignored; but these innovations will not be well served because of the limited scope of this publication. Many of the principles used in the design of traditional science facilities will also be applicable to facilities with specialized uses.

The National Science Teachers Association (NSTA) in its publication, *Conditions for Good Science Teaching*, lists the resources for learning science that should be available in any school as follows:[3]

- "Suitable spaces/places for learning science
- "Appropriate and sufficient science learning materials
- "A modern and comprehensive program of science instruction
- "Competent and enthusiastic science teachers"

It may be argued that the items are not listed in order of importance to learning; however, the vital importance of each item and the interdependence of all of them must be acknowledged. Although the content of this publication emphasizes the first item, "Suitable spaces/places for learning science," program planners at each site are expected to give full consideration to the other three. The *Science Framework* contains a list of ten expectations for science programs. Four of those especially related to considerations for the design of facilities are as follows:[4]

- Science is presented in connection with its applications in technology and its implications for society.
- Science is presented in connection with students' own experiences and interests, frequently with hands-on experiences that are integral to the instructional sequence.
- Students are given opportunities to construct the important ideas of science, which are then developed in depth through inquiry and investigation.
- Textbooks are not the sole source of the curriculum; everyday materials and laboratory equipment, videotapes and software, and other printed materials such as reference books provide a substantial part of student experience.

General guidelines drawn from the *Science Framework* regarding the nature of facilities and equipment required for teaching science, concepts which are applied throughout this publication, are the following:[5]

- Optimal school facilities for science will provide flexibility to accommodate large- and small-group instruction, laboratory activities, outdoor experiences, demonstrations, audio-visual presentations, activities enhanced by educational technology, seminars, and individual or small-group projects. . . .
- Adequate floor and storage space, lighting, ventilation, and [space for a] chalkboard [and bulletin board] must be provided. . . .

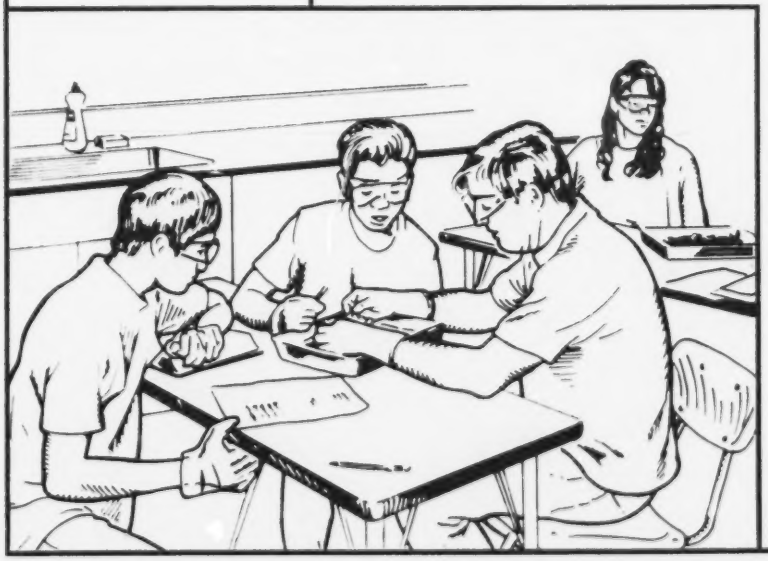


Fig. 1. Science is frequently presented using hands-on experiments that are integral to the instructional sequence.

- Secondary science programs generally require more elaborate facilities, including laboratory stations equipped with running water, gas, electricity, and storage space for student equipment. . . .
- Safe storage for volatile, flammable, or corrosive chemicals is mandatory [at both elementary and secondary levels]. . . .
- Equipment and materials must be made available to all teachers—elementary and secondary. . . .
- Safety is a particularly important component of the learning environment in science. . . .
- Traditional equipment, . . . [as well] as newer technological devices, such as scientific calculators, computers, videotapes, and videodisks, . . . should be constantly evaluated for their contribution to an effective science program.

The *Science Framework for California Public Schools*, which is the core California Department of Education (CDE) publication addressing the kindergarten through grade twelve science curriculum, should be consulted to ensure that the needs of the curriculum are communicated to the site planning and building committees.

As supplements to the preceding publication, *Schools for the Twenty-first Century* (1990) and the *Science Safety Handbook for California High Schools* contain material essential for facilities and program planning.

All of these publications should be readily available to site committees from the earliest stages of planning for facilities and remain in use throughout the program's implementation.

"Safe storage for volatile, flammable, or corrosive chemicals is mandatory [at both elementary and secondary levels]. . . ."

Science Framework for California Public Schools, 1990, p. 178.

CHAPTER I

ENHANCING SCIENCE PROGRAMS THROUGH ARCHITECTURAL DESIGN

Program planning must precede architectural design. A well-designed facility should enhance a program rather than restrict it.

A summary of the wide range of instructional methods that successful science teachers often use (and which should be accommodated in the science facility) is included in the California Department of Education's publication, *Science Education for the 1980s*, as follows:[1]

- *Demonstrations.* A skillfully conducted lecture or demonstration can motivate students to learn more on their own.
- *Group experiments.* Students can work together on experiments, and different groups of students can work on different projects at the same time.
- *Modeling.* Since the development of reasoning and inquiry skills should be a basic goal of any science program, the instructor can help students acquire their skills by "thinking out loud" while conducting experiments and demonstrations.
- *Discussion.* Open-ended discussions about science topics can help to stimulate students' reasoning and creative thinking skills. In a well-conducted discussion, the teacher becomes a guide and facilitator; rather than giving students answers, the teacher helps students find answers by themselves.
- *Multimedia instruction.* Where appropriate, the instructor makes use of films, filmstrips, and self-instructional modules that enable students to work independently. Popular television shows and magazines are also introduced as resources for science education. [Note: Computer technology, laser disks, and so forth should now be added.]
- *Individual investigation or research.* The instructor encourages students to explore science-related topics and problems on their own and to develop science projects.
- *Student tutoring.* When some students are having problems grasping scientific concepts or techniques, the instructor enlists the help of other students as tutors and teaching assistants.
- *Questioning.* The ability to ask the right kinds of questions to stimulate

Fig. 2. A skillfully conducted lecture or demonstration can motivate students.

student learning is critically important to science education. . . .

Several other traditional instructional methods could easily be added to the preceding list, such as testing, lecture, and small-group seminars; however, these methods could be accommodated within facilities designed for the activities listed previously. Program planners must recognize that varied activities take place in a science program, often during the same instructional period and frequently at the same time. Facilities should provide not only for a wide variety of activities but also for easy transition from one activity to another by all or a portion of the students.

Role of the Science Laboratory in Learning

The science laboratory/classroom, with its necessary adjoining storage, preparation, resource, and conference areas, provides the basic physical setting in which the students interact with the learning materials, concepts from the program, and teachers. *Science Education for the 1980s* also contains comprehensive descriptions of effective elementary and secondary school science learning environments. Condensed versions of those descriptions are presented as follows:[2]

1. Science classrooms in elementary schools contain science tables, science kits, and science projects. These materials are essential for various hands-on activities; for example:
   a. Raising and nurturing animals and observing their behavior
   b. Making small animals available to children on weekends through an animal lending library
   c. Using a terrarium to illustrate principles of ecological balance
   d. Displaying rocks, shells, leaves, and other objects found in nature
   e. Providing opportunities to compare, observe, and measure
   f. Providing balances, rulers, thermometers, and other simple measuring instruments
2. Secondary school science classrooms contain diverse materials, such as burners, beakers, and test tubes of various sizes, safety-labeled chemicals, microscopes, specimens, and prepared slides. Classroom walls provide space for interesting displays to stimulate students' curiosity and facilitate learning with the following items:
   a. Posters illustrating the table of elements, human anatomy, laboratory safety rules, and recent scientific and technological developments
   b. Bulletin boards used to report on science-related current events and job opportunities for teenagers
   c. Reports on original experiments developed by participating students

For nearly half a century, the National Science Teachers Association (NSTA) has devoted research to improve science instruction. The organization has concluded that for effective learning, "all students enrolled in science courses should have daily or frequent access to

Facilities should provide not only for a wide variety of activities but also for easy transition from one activity to another by all or a portion of the students.

"All students enrolled in science courses should have daily or frequent access to science laboratories."

Conditions for Good Science Teaching, 1984, p. 4

science laboratories." These laboratories "should be large enough to allow full student participation in setting up, conducting, and storing experiments."[3] "[Laboratories] should be appropriately furnished with work space, storage facilities, and frequently used equipment and supplies. . . ."[4] Each laboratory should have a sufficient number of conveniently located sources of electricity, gas, and water and "should provide adequate, energy-efficient lighting and temperature control for the work to be done."[5]

These statements clearly show that the NSTA has a strong commitment to providing students with hands-on experiences as an integral part of science teaching. NSTA also emphasizes that teachers' careful planning is necessary for these experiences to be truly effective. The need to acquire, store, retrieve, use, and re-store a variety of supplies and equipment during the teaching day indicates that although individual aspects for planning the facilities may be dealt with separately, a comprehensive look at the implications for use of the completed facility will ensure the most effective design.

Configurations and Space Requirements for Science

Early consideration should be given to the following questions, and decisions should be made before a program's needs are submitted to the architect.

Instructional Focus of the District and the School Site

Is there a prevailing district, school site, or departmental instructional innovation that may be greatly affected by the configuration of the science complex; for example, team teaching, individualized instruction, large-group lectures, or small-group laboratories?

Proximity of Classrooms

Should certain science disciplines be located in proximity to one another for sharing equipment, supplies, or facilities? For example, will chemistry and physics classes share use of balances, computers, or power supplies? Will biology, chemistry, and earth sciences share use of pH meters, spectrophotometers, chemicals, and water distilling apparatus? How will facilities, equipment, and supplies be accessed when "coordinated" earth, life, and physical science courses are being taught?

Needs for Space

How much space is or should be provided per science classroom? For the entire science complex? The answers to these questions are obviously linked to special needs, anticipated total science enrollments, class sizes (and the relationships to safe and effective instruction), and the daily classroom load. No clear mandates are available for such questions; however, several guidelines have been provided and will be discussed in Chapter II.

Flexibility

Science facilities should be designed for maximum flexibility because two or more instructional methods must often be used during the same class period, sometimes simultaneously. Two or more teach-

ers (with dissimilar methods or subject matter or both) may commonly share the same instructional space each day. If transition between instructional methods is difficult, instruction will be hindered rather than enhanced. Care should be exercised to avoid designing any instructional space specifically to accommodate a current instructional trend *or* the unique teaching style of any individual teacher because of the uncertain tenure of trends and of individual teachers at a particular site. The design for facilities should *never* determine the teaching method but rather enhance whichever method is chosen.

Flexibility should also be applied when science facilities are being planned that will accommodate projected enrollment and curricular needs. Keeping science instructional spaces adjacent to one another is highly desirable. Insightful provision of electrical or communication conduits helps provide for future curricular or technological changes or both. It is relatively easy and cost effective to plan for future science facilities by installing connections in walls and flooring for drain, water, gas, and electrical lines and by planning for electronic communication such as satellite and computer networks during initial construction.

Safety

Safety cannot be overemphasized, and it should be considered at each point of decision. The equipment and materials used in any laboratory science program bear a hazardous potential through misuse or other unanticipated events. Such events may cause injury to students or teachers or damage to the facility.

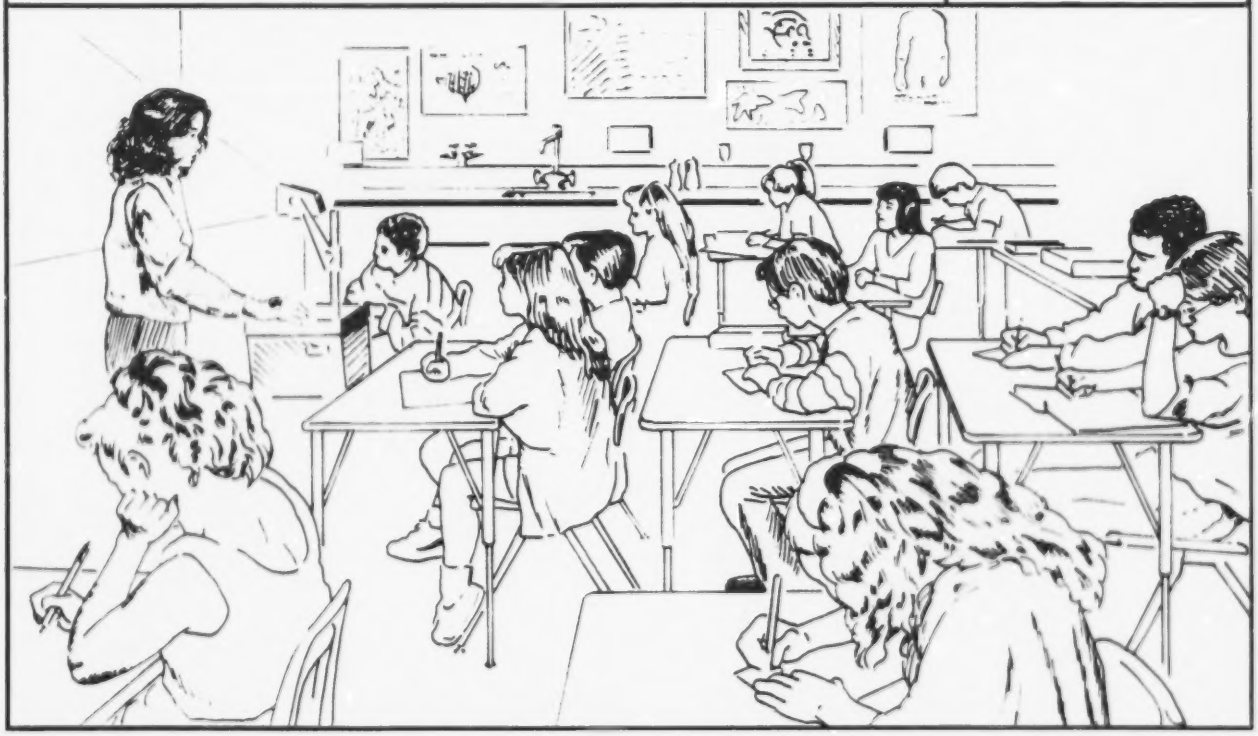


Fig. 3. A laboratory/classroom designed for flexibility is used effectively and comfortably for lectures, demonstrations, audiovisual presentations, and large-group testing. This facility is then easily changed for one or more of a variety of small-group activities.

A science program emphasizing safety, combined with safely designed facilities, can greatly enhance instruction by promoting increased use of hands-on laboratory activities.

The design of facilities can greatly reduce the likelihood of accidents and provide a means of coping with emergencies, thus reducing their effects. A science program emphasizing safety, combined with safely designed facilities, can greatly enhance instruction by promoting increased use of hands-on laboratory activities. In subsequent sections of this publication, much attention is given to designing for safety.

Aesthetics

The design should ensure that the learning areas are comfortable and pleasing. Often, specific aesthetic qualities, such as temperature, humidity, light level, and freedom from noxious or unpleasant odors, are given priority by regulation or common sense. Also important is to consider the visual (such as colors, shapes, sizes, and proximity and angles of seating to view models, charts, and audiovisual screens), acoustical, and olfactory aspects of the learning environment.

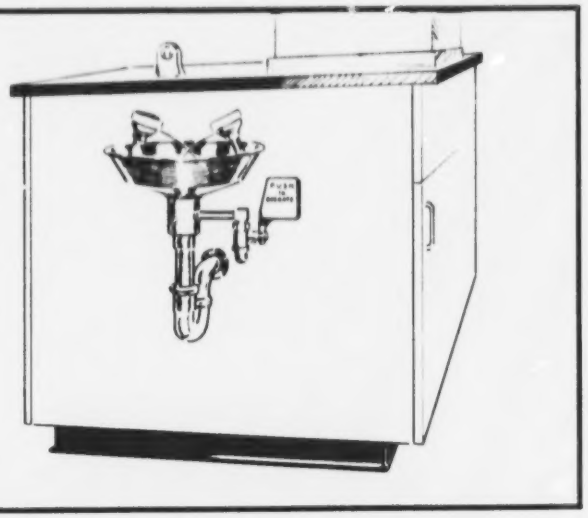


Fig. 4. An easily accessible eyewash station is essential wherever chemicals are used.

CHAPTER II

ARCHITECTURAL REQUIREMENTS AND REGULATIONS

Like all other public school facilities, the facilities for science instruction must meet all the general requirements of pertinent sections of the *Education Code; California Code of Regulations, Title 8, General Industry Safety Orders; Uniform Building Code; Health and Safety Code;* and local fire codes and other building codes specific to the governmental jurisdiction of the school site. In addition, because of the specialized nature of science instruction, construction plans for facilities must comply with a variety of safety requirements related to the storage, use, and disposal of hazardous materials. Many of these requirements are a direct result of state and federal regulations; others result from the field experience of science educators or the experience of maintenance personnel or both. Special planning for science classrooms (and adjunct facilities) should include the following:

- "One-hour" fire doors and fire walls between science facilities (where flammable liquids, hazardous materials, and so forth are stored or used) and nonscience classrooms[1] (*One hour* means that a door or wall can withstand exposure to fire for one hour before the fire penetrates it.)
- A minimum of two exits (required in classrooms where the number of occupants exceeds 50)[2]
- Provisions for disabled students, including at least one laboratory station designed for use of disabled students in each classroom (Special walkways and doorways should also be provided.) (More information about these provisions appears in the *Uniform Building Code* Section 522.)
- An eyewash station (and, where appropriate, a deluge shower) in any classroom or stockroom where splashing of chemicals into the eyes is a possibility (See *California Code of Regulations, Title 8, General Industry Safety Orders,* Section 5162c.) (A related requirement that splashproof safety

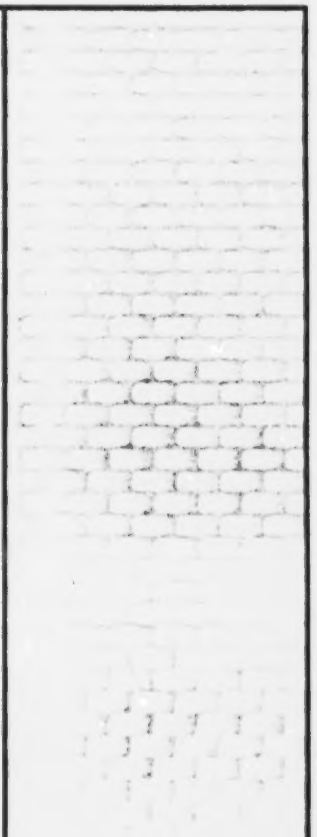
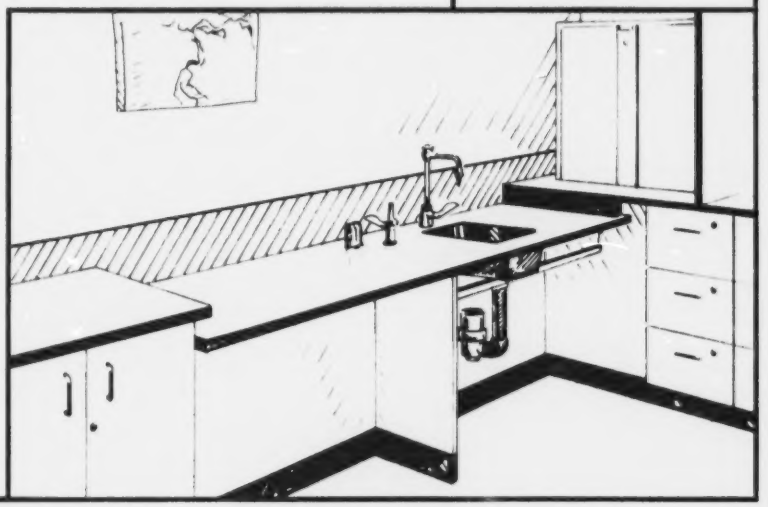


Fig. 5. Typical laboratory stations for disabled students are lower, have open space underneath for wheelchair access, and have modified controls for utilities.



Specialized cabinets, vented to the outdoors, for separate storage of flammable and corrosive chemicals are essential.

goggles also be provided for such conditions suggests that a sanitizing unit [for example, ultraviolet cabinet] and storage for goggles be provided.)

- Chemical-resistant drain lines (Even though "only small amounts of nonregulated, nonflammable, water-miscible liquids may go down the drain"[3] and most local regulatory agencies limit the pH of waste effluent to a range from five to nine, drain lines should be especially resistant to corrosive chemicals.)
- Antisiphon faucets to prevent chemicals, microorganisms, or waste water from being carried into the water supply lines in the event of a temporary loss of water pressure
- Ground fault interrupter and surge protector for electrical outlets to protect personnel and equipment in the event of short circuits or power surges
- Master controls, near the teaching station, to shut off electrical, water, and natural gas outlets in an emergency
- Specialized cabinets, vented to the outdoors, for separate storage of flammable and corrosive chemicals
- Adequate ventilation for the classroom and chemicals storage area (Air in the storeroom for chemicals is to be changed at least four times per hour.)
- Designated temporary storage area for hazardous wastes (See *Health and Safety Code* sections 25500, 25123, and 25123.3.)
- Separate storage provisions for incompatible chemicals
- Plant and animal care facilities with provisions for short-range or long-range maintenance of a variety of living organisms
- Free-standing storage cabinets secured to walls[4]
- Laboratory chemicals (and other objects) on shelves restrained by a wire, lip, or other barrier[5]
- Properly labeled hazardous waste storage containers that will accommodate corrosives, flammables, oxidizers, and so forth

Space Allocations

Space allocations for the total science complex and for the individual component facilities have no clear legal mandate. Because sufficient space is an important safety-related issue, planning should include a careful review of the *Science Safety Handbook for California High Schools*, especially the Introduction and "Storage Patterns." Regulations and recommendations to be used as guidelines for planning are the following:

- The *Uniform Building Code* (*UBC*) (Table 33-A) includes science classes as academic subjects and specifies 20 square feet (1.9 m^2) as a minimum per student compared with a vocational education class, which requires 50 square feet (4.5 m^2) per student. (Unfortunately, the *UBC* does not acknowledge the laboratory component of science courses and therefore makes no provision for such safety concerns as are made in vocational education classes.)[6]
- The *California Code of Regulations, Title 2, Administration,*

Chapter 3, Subchapter 4, Section 1811(g)(2) requires the state architect to design laboratory/classrooms for occupancy of 26 students in grades seven through twelve or 24 students in grades nine through twelve. Dividing the area by the number of students yields about 50 or 54 square feet (4.5 m^2 or 4.9 m^2) per student, respectively. These design specifications are generally understood by state and local agencies to be equivalent to 1,300 square feet (117 m^2) of floor space, *including preparation and storage space.*

- The NSTA recommends a minimum of 5.5 square meters (58.8 $ft.^2$) of space per student in a classroom/laboratory or 4 square meters (43 $ft.^2$) per student if the space is strictly for a laboratory, and no more than 24 students should be assigned to a laboratory and a teacher at one time unless the school has been built following an open area concept.[6] The NSTA suggests minimum space for storage of supplies and equipment at 15 percent of the laboratory space served.[7] Preparation and office space is additional.

Relationship of Space, Class Size, and Safety

These regulations and recommendations suggest the simultaneous examination of the following issues: (a) areas (square feet or square meters) of laboratory/classrooms; (b) number of laboratory stations in each laboratory/classroom; and (c) class size. The Introduction to the *Science Safety Handbook*, a section that examines the relationships among space, class size, and safety, may prove valuable to the planning committee.[8] That publication suggests that the following be considered in making such decisions:

1. The number of students that one teacher can supervise in a potentially dangerous activity
2. The degree of personal risk
3. The increased liability when class size exceeds 24 students
4. The level of maturity and knowledge of safety that students bring to the science laboratory
5. The space required for each student to perform experiments safely

All architects or planning committee members or both that do not have *recent* experience in planning, designing, and constructing school science facilities should not only review all available literature on the topic but also visit and obtain recommendations from school site personnel and architects who have had such experience. Architects and planners without recent experience also need to keep close contact with the California Department of Education's School Facilities Planning Division and the Science and Environmental Education Unit, the Office of the State Fire Marshal, and the Office of the State Architect for advice and interpretation of regulations. Information about funding may be obtained from the California Department of Education's Office of Local Assistance (OLA).

Fig. 6. NSTA suggests minimum space for storage of supplies and equipment at 15 percent of the laboratory space served.

CHAPTER III

STEPS IN THE PLANNING PROCESS

Although no school district would (or should) plan and implement a new facility development in precisely the same way in which another school district proceeds, logical steps must be taken—some in sequence, some in unison, but all coordinated—to ensure the timely completion of the project. The active support and involvement of the district's governing board are essential. For every decision the board makes, however, the members must rely largely on the planning efforts and recommendations of professional science educators, district business services staff, interested community members, and an architect. Typical steps in planning for a new (or remodeling an old) facility would include the following:

1. Board approval of the decision to build
2. Selection of a site
3. Educational specifications developed and approved
4. Architect selected
5. Budget determined, schematics for construction developed, and staff review completed
6. Architect's contract awarded
7. Preliminary plans and staff review completed
8. Construction documents and staff review completed
9. Approval from the Office of the State Architect received
10. Bids advertised and received
11. Construction contract awarded
12. Construction begun and completed
13. Facility equipped and furnished

Each of the preceding steps is a process in itself, and some steps need more extensive explanation than others; for example:

Step 1. *Board approval* occurs after preliminary studies have been made to (a) verify the need for new

Fig. 7. School grounds can be landscaped to enhance field studies of native plants and animals. Hacienda Science/Environmental Magnet School, San Jose, San Jose Unified School District

construction; (b) project the district's approximate enrollment patterns; (c) assign the desired completion date; and (d) estimate costs to plan, construct, and furnish the facility. An experienced site administrator should be assigned to coordinate planning among the architect, science teachers and curriculum experts, other district staff, and key community representatives.

Step 2. *Selection of a site* is next. The school site probably has already been determined. If not, a location favoring the availability of resources such as wildlife preserves, aquatic areas, rivers, wooded or other natural areas, science-related industries, institutions of higher learning—to name a few—would be desirable. These locations and others may be obvious as the potential sites are considered. Most likely, other factors such as availability, location of needs, or terrain or fiscal considerations or both have long since determined the location. The California Department of Education's School Facilities Planning Division can provide valuable assistance regarding selection of a site.

Step 3. *Educational specifications* must be developed and approved. A committee consisting of an administrator, experienced science educators, and interested community members should describe clearly and concisely the activities that will take place in each laboratory/classroom and accessory room. The architect, if identified, should participate in these proceedings and assume a support (rather than a lead) role. Chapter I, "Enhancing Science Programs Through Architectural Design," and the publications from the California Department of Education listed on the last page of the Introduction would be valuable tools for this committee. Members of the committee should also provide recommendations for the overall planning process for the site as early as possible and continue as long as such contributions are usable.

Step 4. The *selection of an architect* is among the most important decisions that will be made. (Note that one of the steps is awarding the architect's contract. For preliminary planning it may be possible to retain an architect who has not previously worked with the district. The architect would serve a trial period with a provision that if the experience proves unsatisfactory to either party, the relationship could be terminated.) A creative, thorough, cooperative, and persistent architect can produce a pleasing, functional facility on schedule and without significant pressure from the district's staff—resulting in a rewarding experience for all involved. To select an architect, the district should:

- Develop a list of desirable qualities and criteria for selection; for example:[1]
  a. Is able to work as a team with any who can and should provide recommendations for the project
  b. Demonstrates analytical capability and will offer and seek alternative solutions in achieving the optimum design (The architect has ideas and opinions but shows reasonable flexibility.)
  c. Has had successful experience (verified through visits to sites) in similar projects,

Most likely, other factors such as availability, location of needs, or terrain or fiscal considerations or both have long since determined the location.

Before a contract is awarded, it would be advisable to give the architect a retainer for developing a* budget *and presenting preliminary* schematics *for construction.

especially involving interior design, storage, cabinetry, plumbing, and so forth—preferably in school science facilities

d. Has the ability to control costs within estimates that he or she provides

e. Is able to keep the project on schedule

- Check references for evidence of favorable performance on similar projects.
- Request recommendations for qualifications of architects from the business managers, directors of facilities, and/or science managers of other local school districts.
- Acquire a list of potential architects from the local chapter of the American Institute of Architects (AIA) or from the California Council of AIA.

The California Association of School Business Organizations (CASBO), Coalition for Adequate School Housing (CASH), and Association of California School Administrators (ACSA) may also provide valuable source information.

Step 5. Before a contract is awarded, it would be advisable to give the architect a retainer for developing a *budget* and presenting preliminary *schematics for construction.* The credibility of the architect and his or her staff would be established as they work with the school's staff in designing science facilities that meet the specifications of the committee planning the structure.

Step 6. The *architect's contract is awarded* contingent on satisfactory completion of Step 5.

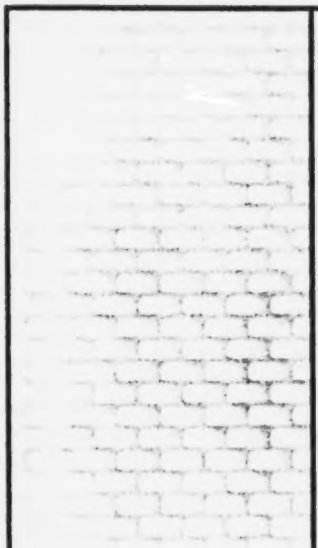
Steps 7 and 8. *The staff members complete their review of preliminary plans and construction documents.* Progressive submittal of plans provides several opportunities for the committee as well as for other district staff to suggest modifications that would improve the instructional program. When plans are being reviewed, it is advisable to bring them into existing science rooms and arrange furniture to simulate the details, thus ensuring that the spaces provided will be adequate when students occupy them. During these reviews a record must be kept of agreed-on modifications, and the agenda of the next meeting must include a procedure to ensure that these modifications have been included on revised plans and, of course, on the construction documents.

Steps 9 through 11. *The Office of the State Architect must approve the project, bids must be advertised and received, and the construction contract needs to be awarded.* These steps are time-consuming but essential in the total process. Depending on the magnitude of the construction planned, four or more months may easily be consumed. The construction documents should provide for instructional needs, and this period of time should be used for careful review of those needs to determine whether any essential elements have been omitted. This is also an opportunity to give any remaining necessary attention to Step 13.

Step 12. *This step involves the beginning and completion of construction.* Although the architect is responsible for ensuring that the

contractor is meeting the requirements of the construction documents, a district person who has been an integral part of the planning process and who would recognize whether plans had been misinterpreted should also keep close contact during construction.

Step 13. *Equipment and furnishings*, although listed last, should be a part of the initial planning. To ensure maximum control over the purchase of the items (and reduce the overhead costs), planners should consider equipment, furnishings, and supplies not physically attached nor requiring separate installation as not in contract (NIC); thus, the architect is not responsible for their acquisition. Specifications must still be prepared (by the educational specifications committee), and someone made responsible to place orders for delivery coincident with completion of the facility. Because many items such as tables, bookcases, desks, or file cabinets may have to be fabricated after the order has been received, the specifications and order lists should be prepared during or immediately following development of the educational specifications.



The classroom setting can encourage curiosity and provide motivation for students to learn more science.

CHAPTER IV

ELEMENTARY SCHOOL SCIENCE FACILITIES

The *Science Framework for California Public Schools* states that "The elementary school science curriculum holds great potential for exploring natural phenomena and technological applications in science. At a time when children are most curious about the world, teachers can capitalize on this joy of learning in ways that make science enjoyable, interesting, and meaningful."[1] The classroom setting can encourage curiosity and provide motivation for students to learn more science. The *Science Framework* contains suggestions for arranging the science classroom environment to promote learning:[2]

- Science equipment and materials, as well as reference books and periodicals, should be visible and within easy reach of the students.
- Bulletin boards can display the results of the most current unit of study, from student work to related articles, including science careers and technology.
- A number of study areas in the room [or on the campus] can be devoted to science learning, making it clearly evident that this is an environment that encourages questioning and inquiry.
- [Classroom tables can be arranged to enable students] to work in cooperative groups, perform investigations, manipulate science equipment, and follow safety precautions.

Facilities for the Self-contained Classroom

Most elementary schools have not used separate facilities for teaching science. To best accommodate the teaching of science in the self-contained classroom, program planners for elementary schools should provide the following conditions:

- A sufficient number of flat, laminated plastic or plastic laminate-topped student tables or desks and space for arranging them so that the class can work in two's, three's, or four's and have walkway areas for the distribution and sharing of materials
- A holding area in each classroom for ongoing projects of several days' to a few weeks' duration
- Adequate space in each classroom to house science learning centers for extension activities and for optional enrichment or reinforcement lessons
- Counter space that is resistant to heat and chemicals and is equipped with a sink, tap water, and an adjacent electrical outlet (More than one such space should be provided if feasible.)
- Ample lockable classroom storage space for apparatus, materials, and kits

- Access to the outdoors for observing natural phenomena—if possible, an outside area designed for students' use
- White dry-erase boards instead of chalkboards (Consider the type that may double as a projection screen.)

Facilities for the Science Laboratory/Classroom

As in-depth approaches to science education become more commonplace at all grade levels (kindergarten through grade twelve), expectations will increase for the elementary schools to provide more and better science instruction. State Superintendent Bill Honig, in his December 13, 1989, Education Summit, recognized this special need in calling for at least one science laboratory/classroom for each elementary school. An elementary classroom/laboratory devoted primarily to science should have the following:

- Additional sinks (one with an eyewash station adjacent)
- Electrical outlets available to student tables
- Shelves with fluorescent and incandescent lighting to grow plants
- Hot water at one sink
- Movable laboratory demonstration cart with vertical bars and top resistant to heat
- A framing subsystem adequate to "hang things from"
- Audiovisual capabilities, including darkening curtains, projection screen, 16 mm film projector, overhead projector, video/laser disk, video camera adaptable to microscope, VCR/TV, or the latest technological equivalents for each of the preceding items
- A display case, preferably near the entrance, for exhibits of apparatus, charts, specimens, and so forth, that stimulate students' interest in science
- One or more computer stations, one modem, and potential for expansion to possible future modes
- An eyewash station

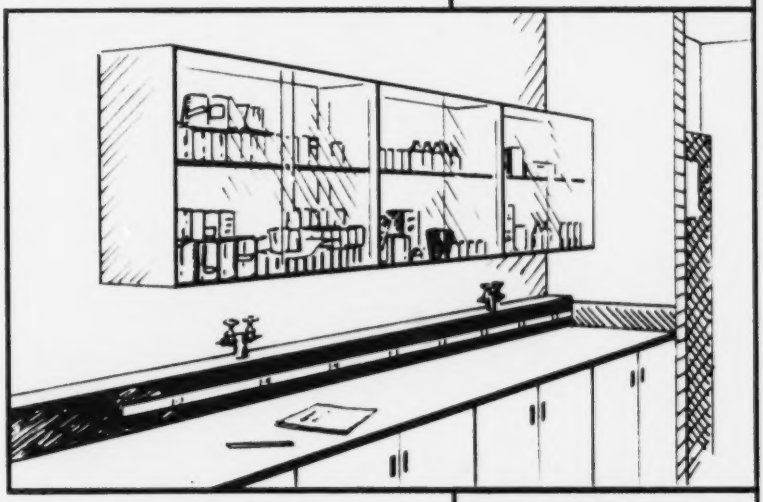


Fig. 8. Lockable classroom storage space for apparatus, materials, and kits is essential for science instruction.

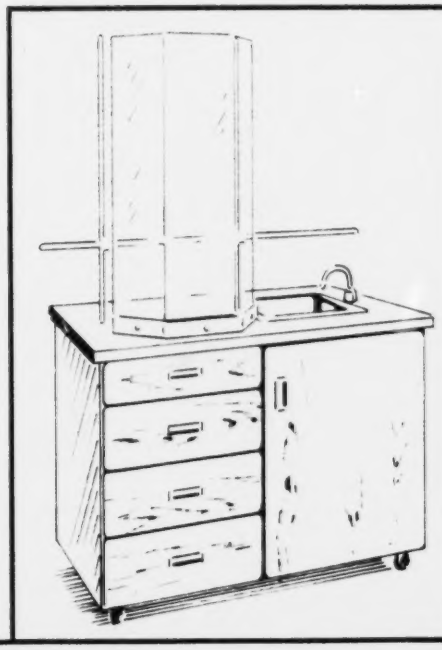


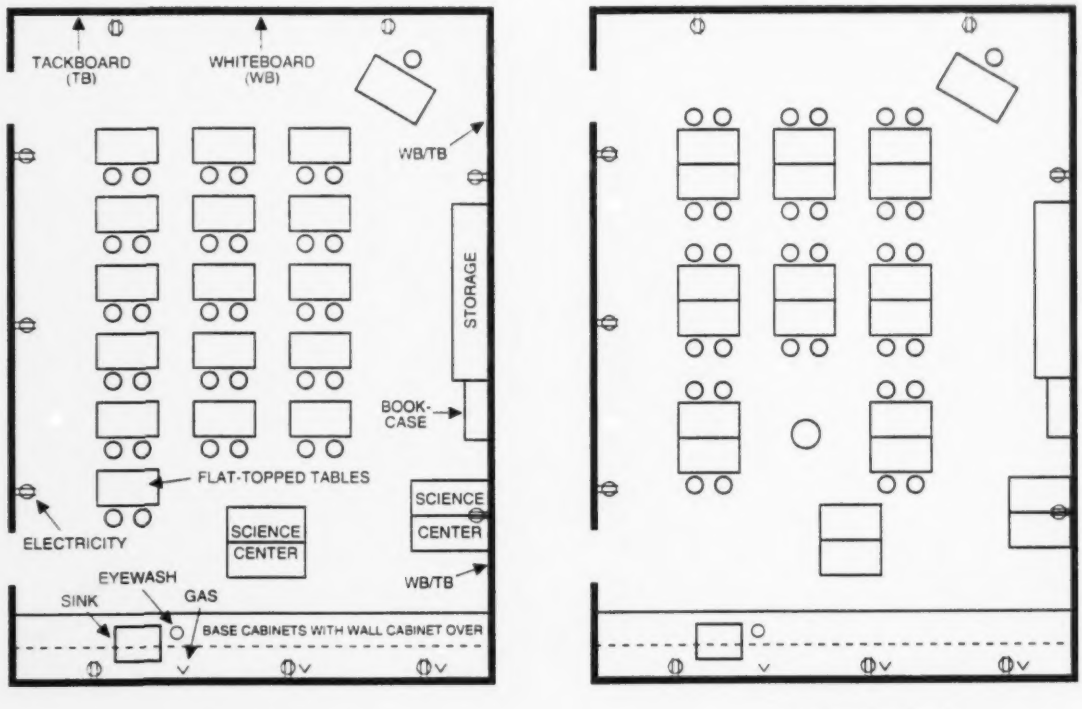
Fig. 9. A movable laboratory demonstration cart can be designated for special use or shared by several teachers at an elementary school, middle school, or senior high school.

- One laboratory station designed for the disabled, with appliances and accessibility suitable for use from a wheelchair

Figure 10 shows sketches of an elementary self-contained classroom with science centers. The student tables are shown as arranged for typical nonlaboratory activities and also for science hands-on activities. *Note:* Each laboratory team could arrange its tables adjacent to an electrical outlet, if necessary, and one of the science centers could include a computer station.

Figures 11 and 12 are examples of rooms designated for full-time science use at the elementary level.

Fig. 10. Elementary Self-contained Classroom with Science Centers



Nonlaboratory Mode

Laboratory Mode

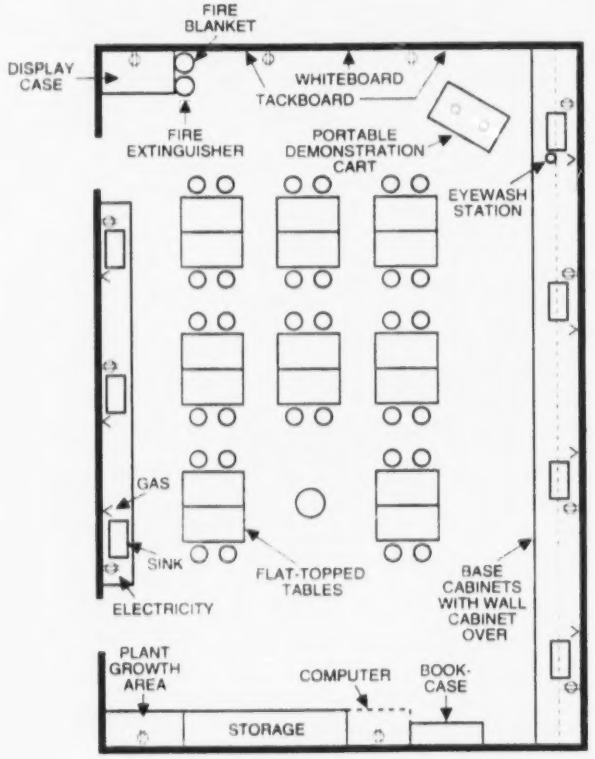


Fig. 11. Example of an Elementary Science Room

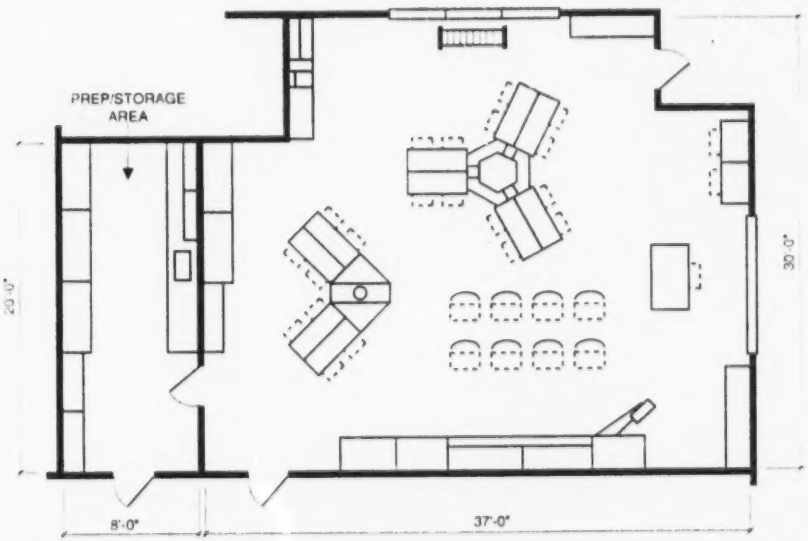


Fig. 12. Science Area for Kindergarten Through Grade Six

Adaptable for kindergarten through grade six science, the floor plan uses specialty items that facilitate the study of the direct relationship of mathematical calculations to science discovery. Also, the service island with the students' tables can be used for small-group experiments or a lecture setting.

Adapted from *Planning a Safe and Effective Science Learning Environment.* Austin: Texas Education Agency, 1989. p. 30. Reprinted with permission from the publisher.

CHAPTER V

MIDDLE SCHOOL SCIENCE FACILITIES

Beginning no later than grade seven, however, students should be enrolled daily in one class period of science taught by a subject area specialist in a space designed to accommodate a wide variety of science learning activities.

In most curricular areas middle school programs are seen as transitions from the foundation provided during the elementary grades to the specialization of the high school years. This concept is especially applicable to science programs in middle schools. According to the *Science Framework for California Public Schools,* "Students should be able to appreciate the connections among disciplines and to apply higher-level thinking processes in their study of science."[1] So that students in middle schools are prepared for high school science courses, the *Science Framework* recommends that:

- Science be taught every semester the student attends middle school.
- "Science lessons . . . be highly experiential, manipulative, and laboratory oriented. Students should be working in small groups, cooperating on peer-group projects, and solving laboratory-oriented problems.
- "Consistent with the recommendations from *Caught in the Middle: [Educational Reform for Young Adolescents in California Public Schools],* students in the middle grades are ready to assume responsibility for a larger share of their learning. Middle grade science teachers can offer students the opportunity to select projects that are consistent with the curriculum for the course and involve considerable [work outside the classroom]. . . . Whether schools adopt a project orientation to their science program or not, at least 40 percent of the class time should be spent on activity-based lessons."[2]

Facilities designed for elementary school science would be adequate for students through grade six, with the full-time science facility used whenever subjects become departmentalized. Beginning no later than grade seven, however, students should be enrolled daily in one class period of science taught by a subject area specialist in a space designed to accommodate a wide variety of science learning activities. The science laboratory/classroom for grades six through eight should have:

- Flat, laminated plastic-topped student tables and space for arranging them so that the class members can work in two's, three's, or four's and have walkway areas for the distribution and sharing of materials
- Storage for ongoing projects of several days' to a few weeks' duration and for supplies, apparatus, and equipment used continually

- An adjacent project room for extension activities, optional enrichment, or reinforcement lessons and seminars
- One or more computer stations with conduit in place to provide for networking departmentwide and expansion into possible future modes and one telephone line and modem
- Audiovisual capabilities for 16 mm film, overhead projection, video/laser disk, video camera adaptable to microscope, VCR/TV, or the latest technological equivalents of the preceding items, and departmental networking of the electronic media
- Access by each student team to counter space resistant to heat and chemicals, including a sink with tap water, a gas jet, and an electrical outlet (A conduit from the laboratory station to the computer area for future interface is also recommended.)
- Immediate access (by the teacher) to a central storage/preparation room for shared apparatus and materials
- Access to the outdoors for observing natural phenomena—if possible an outside area designed for students' use
- A display case, preferably near the entrance, for the display of apparatus, charts, specimens, and so forth that stimulate students' interest in science
- Movable laboratory demonstration cart with vertical bars and a top resistant to heat and chemicals
- Large cleanup sink (optional, depending on curricular needs)
- Fume hood (This item is optional, depending on curricular needs, but

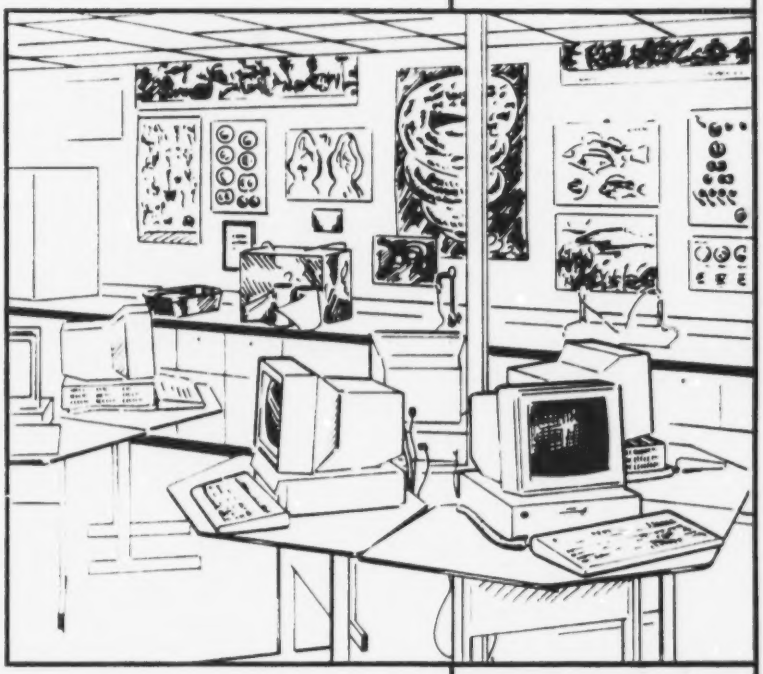


Fig. 13. Computer stations with conduits to student laboratory stations and to a centralized location provide for future laboratory equipment interface and for networking.

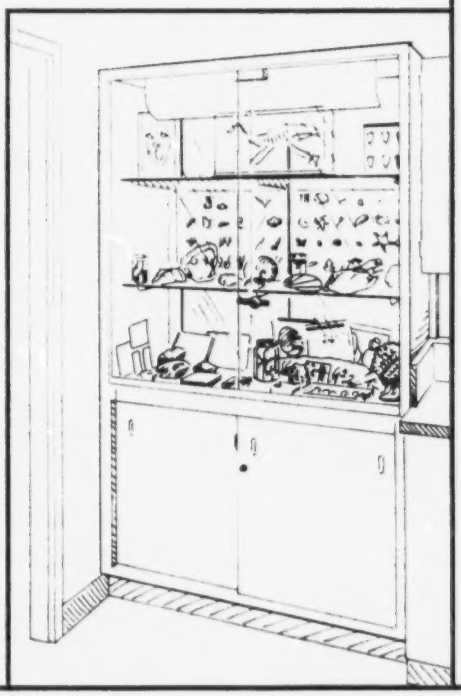


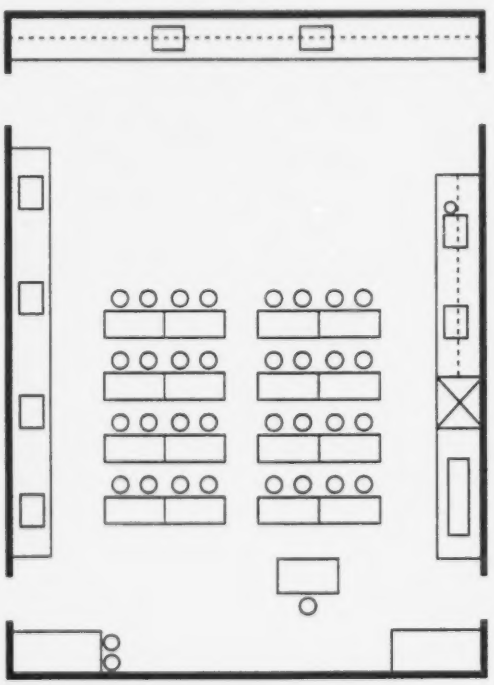
Fig. 14. A display case for apparatus, charts, or specimens that stimulate students' interests in science should be near the entrance of every science classroom.

Fig. 15. Middle School Science Laboratory/ Classroom

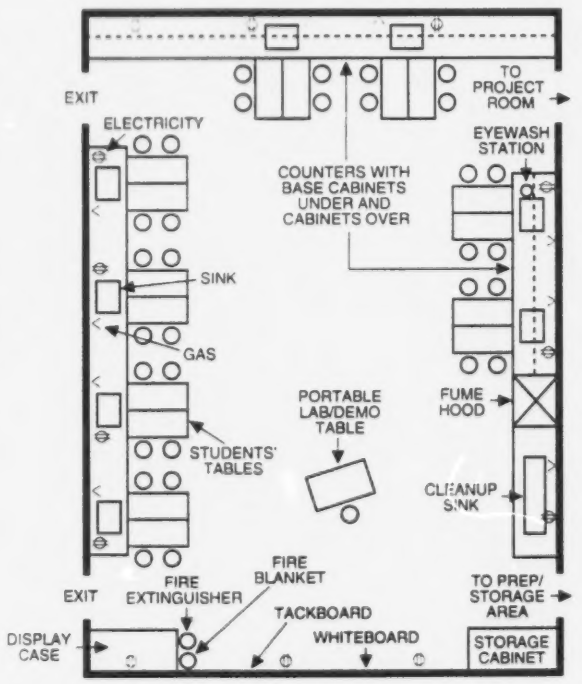
a roof jack [metal or plastic flashing to seal the roof where the vent protrudes] and a chase [a recess for the passage of pipes] should be included for easy installation of the fume hood. The preparation and storage areas should be equipped with a fume hood.)

- Eyewash station
- Deluge shower (optional, but desirable) if corrosive chemicals will be handled
- Provisions for the use of or conversion to microchemical techniques with computer assistance (A conduit should lead from laboratory stations to the computer area for wiring or fiber-optic interface between the laboratory station and computer.)
- Access for the disabled regarding laboratory space, doorways, and walkways

Science departmental configurations for middle schools may be patterned after those for high schools (see Chapter VI). A sketch of one possible basic middle school science classroom is shown in Figure 15.



Nonlaboratory Mode



Laboratory Mode

CHAPTER VI

HIGH SCHOOL SCIENCE FACILITIES

Planning high school science facilities to meet present and future curricular needs can be a rewarding, though challenging, experience because facilities need to be planned to accommodate varied approaches to science instruction. "Strong traditions exist regarding what high school biology, chemistry, and physics courses should be like. Regardless, many excellent options for teachers and students have been developed."[1] The facilities, equipment, and materials should give ample evidence of these options, with provisions for change and for future advances in technology. Excerpts from the *Science Framework* especially pertinent to planning high school facilities follow:

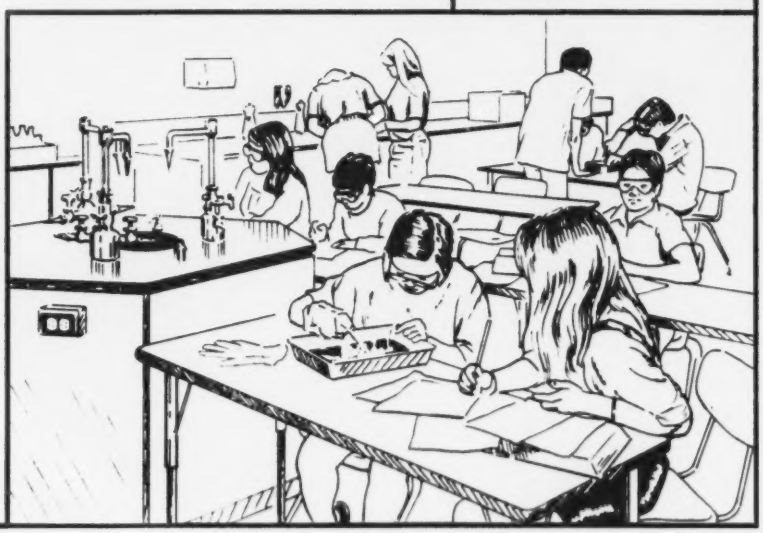
- Technology-based programs are part of the advanced curriculum and have been designed to reinforce basic science understanding as well as to explore specific technological areas.[2]
- In the laboratory [students] can organize work in groups, are motivated to complete experiments, [can] create professional-looking records of [their results], and are responsible for their own safety, understanding the need for personal protection and mature behavior.[3]
- Students should spend at least 40 percent of their time on practical activities designed to foster manipulative skill development as well as higher-order thinking.[4]

Unique Needs of Individual High School Science Disciplines

All of the features previously listed in Chapter V (and repeated here) for the middle school science laboratory/classroom are necessary and appropriate for high school science. Facilities for high school science should have:

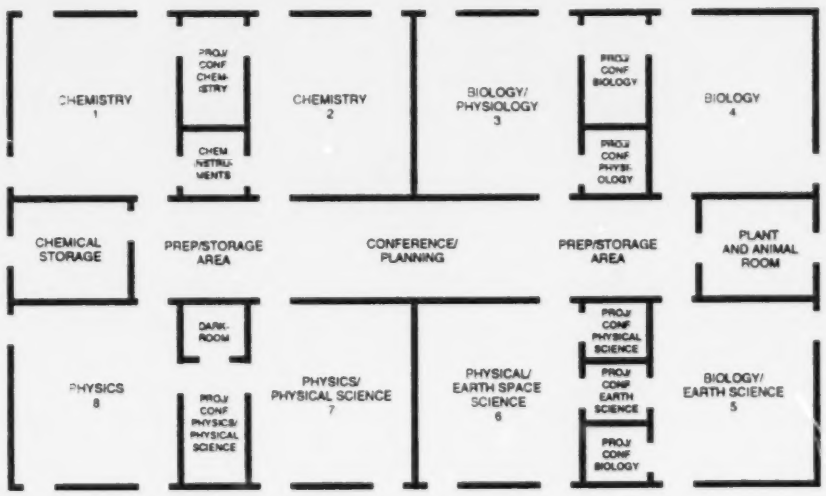
- Flat, laminated plastic-topped student tables and space for arranging them so that the class members can work in two's, three's, or four's and have walkways for the distribution and sharing of materials
- Storage for ongoing projects of several days' to a few weeks'

Fig. 16. Flat-topped tables and space for arranging them so that students can work in two's, three's, and four's are in every science classroom.



duration and for supplies, apparatus, and equipment used continually

- An adjacent project room for extension activities, optional enrichment, or reinforcement lessons and seminars
- One or more computer stations with conduit in place to provide for networking departmentwide and expansion into possible future modes and one telephone line and modem
- Audiovisual capabilities for 16 mm film, overhead projection, video/laser disk, video camera adaptable to microscope, VCR/TV, or the latest technological equivalents of the preceding items, and departmental networking of the electronic media
- Access by each student team to counter space (resistant to heat and chemicals; for example, resin tops), including a sink with tap water, a gas jet, and an electrical outlet
- Immediate access (by the teacher) to a central storage/preparation room for shared apparatus and materials
- Access to the outdoors for observing natural phenomena—if possible an outside area designed for students' use
- A display case, preferably near the entrance, for the display of apparatus, charts, specimens, and so forth that stimulate students' interest in science
- Movable laboratory demonstration cart with vertical bars and a top resistant to heat and chemicals
- Large cleanup sink (optional, depending on curricular needs)
- Fume hood (This item is optional, depending on curricular needs, but a roof jack [metal or plastic flashing to seal the roof where the vent protrudes] and a chase [a recess for the passage of pipes] should be included for easy installation of the fume hood. The preparation/storage area should be equipped with a fume hood.)
- Eyewash station
- Deluge shower (optional, but desirable) if corrosive chemicals will be handled
- Provisions for use of or conversion to microchemical techniques with computer assistance. (A conduit should lead from laboratory stations to the computer area for wiring or fiber-optic



University City High School, San Diego, San Diego City Unified School District. Adapted from a floor plan developed by Wheeler, Wimer, Blackman, and Associates in San Diego. Reprinted with permission from the San Diego City Unified School District.

Fig. 17. Large School Arrangement

interface between the laboratory station and the computer.)

- Access for the disabled regarding laboratory space, doorways, and walkways

In addition, each of the science disciplines has unique needs that should be provided in rooms designated for that discipline. In general, the features of a life science classroom can easily accommodate multidisciplinary use; therefore, these basic facilities are considered interchangeable. The apparatus and supplies provided for specific use would, of course, be quite different.

Life Science (and Multidisciplinary) Laboratory/Classroom

For biology and physiology there should be:

- Provisions for enclosed storage and security of microscopes and balances
- Considerations for proper ventilation if volatile solvents are being used or if preserved specimens are being stored or dissected (If the room is air-conditioned, a separate purge system to exchange room air rapidly with outside air is recommended.)
- A fume hood (If the curriculum requires other than an occasional demonstration use or shared use, up to one fume hood or other vapor recovery system per laboratory group may be necessary.)
- Provisions for storage and display of study collections
- A place to grow and maintain cultures of protozoans, bacteria, and small plants and places where small animals can be propagated and appropriately cared for
- A large sink for cleanup with hot and cold water
- A refrigeration/heater system for marine aquaria (optional)

Figures 19 and 23 show sample sketches of multidisciplinary science

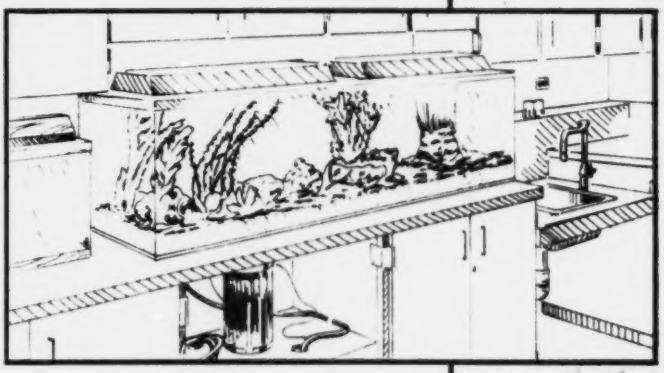


Fig. 18. A marine aquarium system can promote special interest and learning otherwise impossible except in coastal communities.

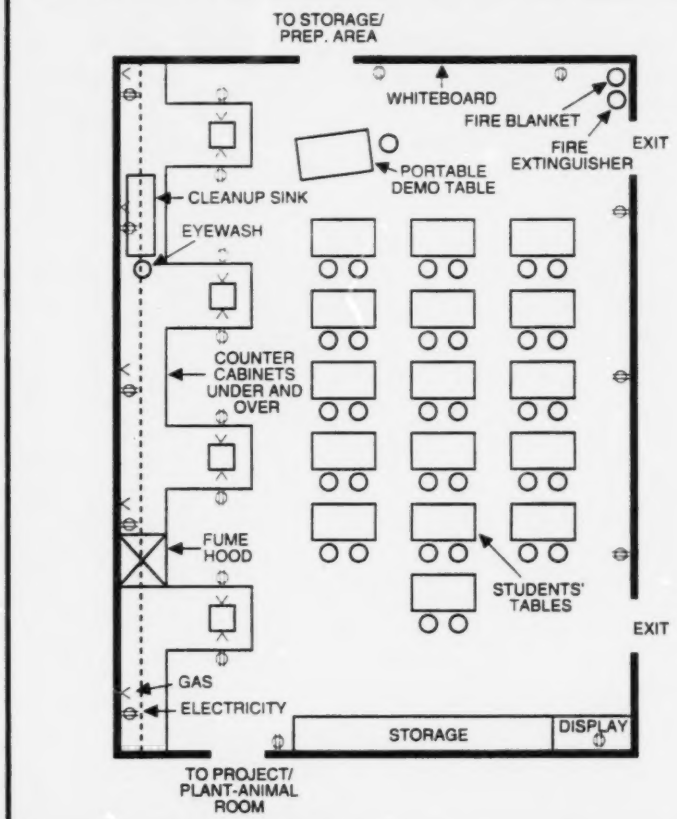


Fig. 19. Sample Life Science Lecture/Discussion Mode (or Multidisciplinary Science Laboratory/ Classroom)

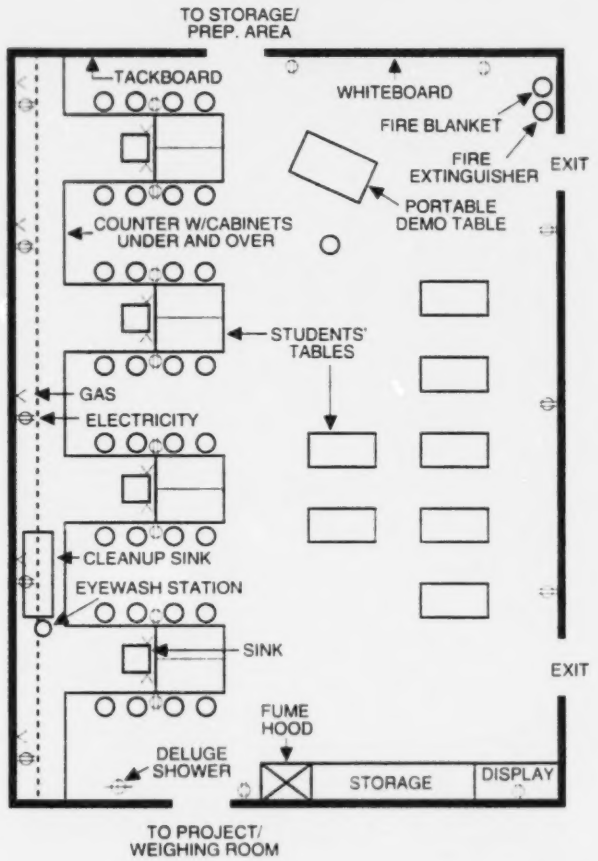


Fig. 20. Sample Chemistry Laboratory/ Classroom, Laboratory Mode

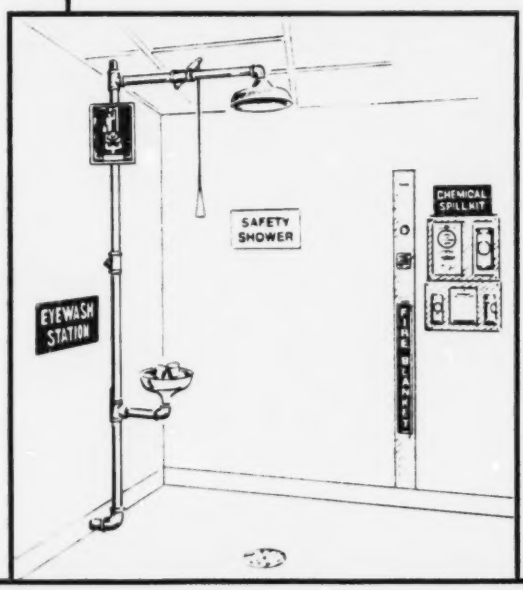


Fig. 21. An emergency deluge shower with drain or a combined emergency eyewash station and shower facility should be readily accessible to each chemistry laboratory.

laboratory/classrooms for life science/biology. Figure 20 shows how facilities in Figure 19 can be arranged in a laboratory mode.

Chemistry Laboratory/ Classroom

For chemistry there should be:

- Special provisions for safe storage (preferably in a separate room designed for that purpose), handling, dispensing, and disposal of toxic, corrosive, and flammable chemicals
- Counters and working areas especially resistant to chemical action as well as to heat; for example, resin or synthetic slate
- Readily accessible room for secure storage and computations (for example, weighing room) that can isolate and protect electronic equipment from chemical action and be locked
- Separate air conditioning/ventilation and, preferably, each laboratory station to be serviced by an individual fume-removal system
- An emergency deluge shower with drain or a high-volume combined emergency eyewash station and shower facility[5]
- A manually controlled purge system to exchange room air rapidly with outside air in the event of considerable release of toxic or otherwise objectionable fumes[6] (This system is necessary unless there is excellent ventilation; for example, large, openable windows and cross ventilation.)
- A large cleanup sink with hot and cold water
- Student tables, if used as supplementary space for chemistry

laboratory activities (The tables should be counter height, 36 inches [91 cm], to prevent, or reduce the effects of, chemical spills in students' laps. Corresponding chairs should be adjustable up to 25 inches [63.5 cm].)

Figures 20, 24, and 25 show sample sketches of chemistry laboratory/classrooms.

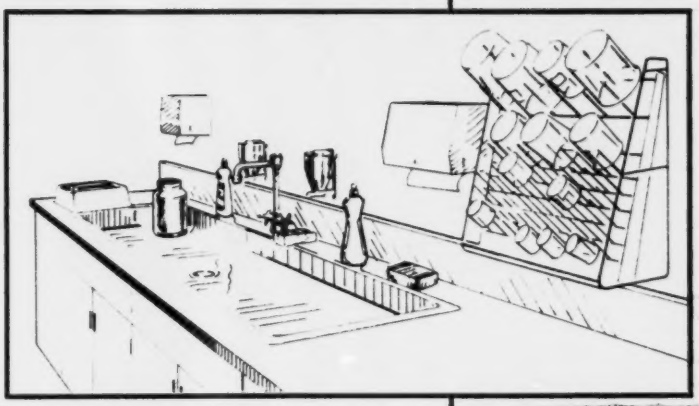


Fig. 22. A large cleanup sink can increase learning by reducing the time needed to keep glassware clean and orderly.

Physics Laboratory/ Classroom

For physics special provisions should be made for:

- "Security in storage of the variety of expensive electronic equipment"
- Longer expanses of flat space (for lasers or holography, air track or table, and dynamics cart experiments)[8]
- Greater overhang on countertops to accommodate clamps for stands and so forth
- Film developing (and silver recovery unit)
- Telescope use
- Apparatus suspended from the ceiling for experiments on motion; for example, a framing substructure to hang things from

Figures 26 and 27 show sample sketches of physics laboratory/ classrooms.

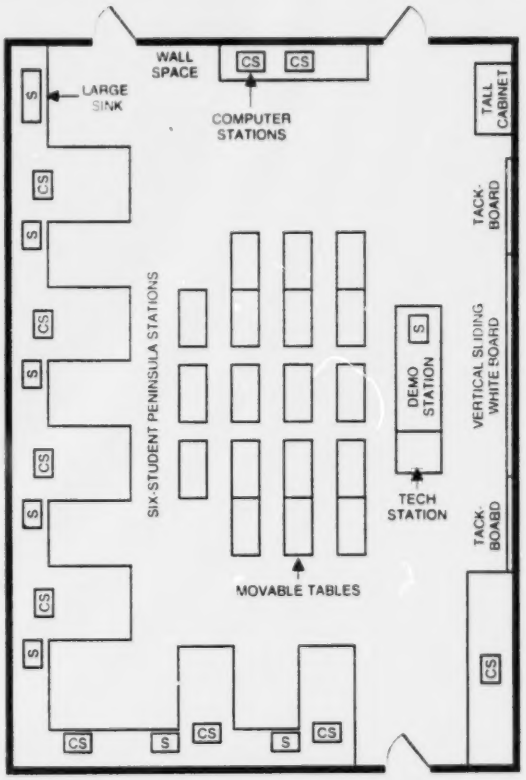
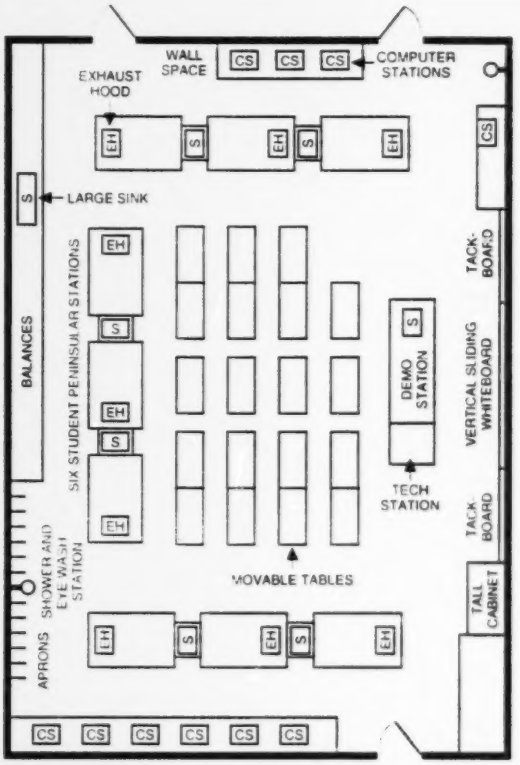


Fig. 23. Biology/ Physics Laboratory

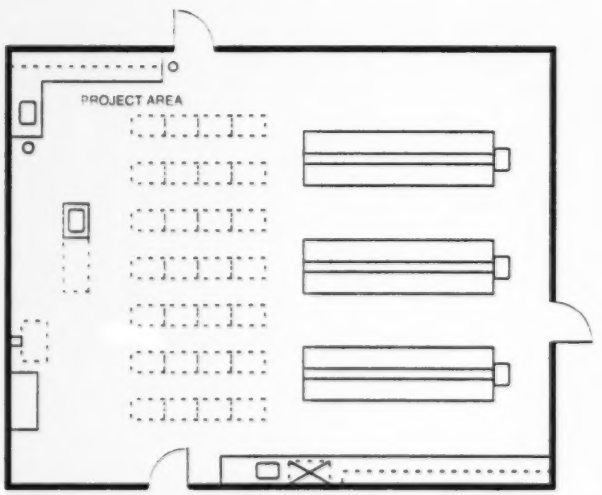
Sanders, Linda K., and Joseph R. Sanders. *The Supervisor's Role in Planning Science Facilities: Specifying Outcomes.* Long Beach, Calif.: Long Beach Unified School District, 1991. Reprinted with permission from the Long Beach Unified School District.

Fig. 24. Chemistry Laboratory



Sanders, Linda K., and Joseph R. Sanders. *The Supervisor's Role in Planning Science Facilities: Specifying Outcomes*. Long Beach, Calif.: Long Beach Unified School District, 1991. Reprinted with permission from the Long Beach Unified School District.

Fig. 25. Chemistry Laboratory Classroom



Adapted from science building, James Madison Senior High School, San Diego, San Diego City Unified School District. Adapted from a floor plan developed by Tectonics Architects, Planners, Engineers, San Diego. Reprinted with permission from the San Diego City Unified School District.

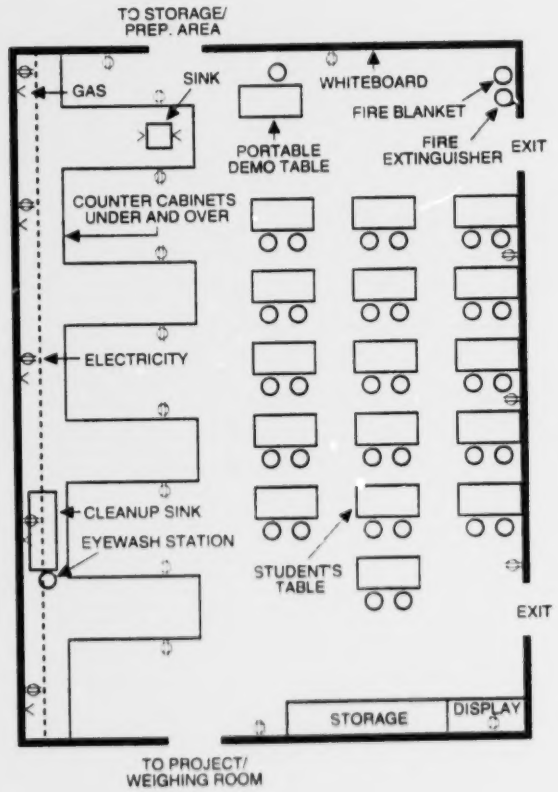


Fig. 26.
Sample Physics Laboratory/Classroom Lecture and Discussion Mode

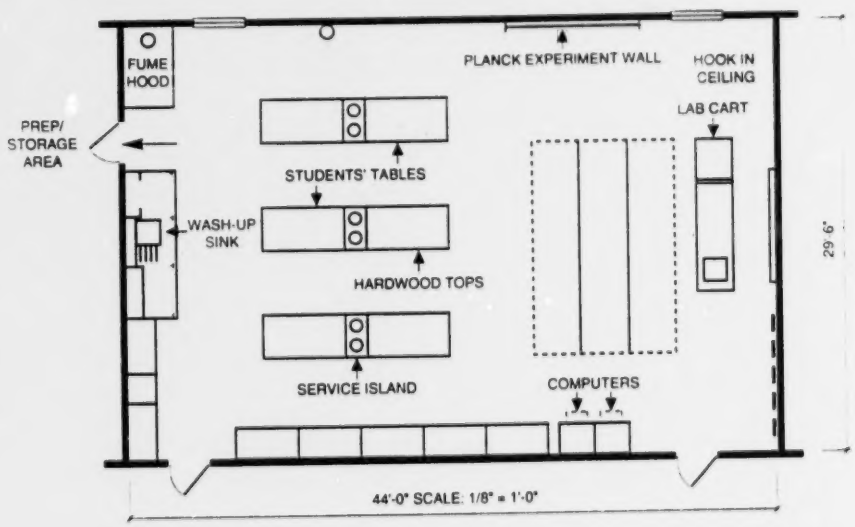


Fig. 27.
Physics Laboratory

The service islands have two complete sets of utilities with large movable students' tables with edge-grain hardwood tops. A large wash-up sink and small fume hood are shown in the back of the room.

Adapted from *Planning a Safe and Effective Science Learning Environment.* Austin: Texas Education Agency, 1989, p. 40. Reprinted with permission from the publisher.

CHAPTER VII

THE SCIENCE COMPLEX—FROM SITE DEVELOPMENT TO OCCUPANCY

The site to be developed should be carefully studied to assess the physical resources available. The location of the science facilities within the total site should include careful consideration of the following:

- Access to any natural areas near the site (Agreements may be required with those persons in control of the area.)
- Space adjacent to the science area with sun exposure for a greenhouse, planting area, or pond (Landscaping should be planned with the science curriculum in mind. A portion of the site should be preserved in its native state, including trees, shrubs, and rock formations, if possible.)
- Reasonable proximity to the library or media center and central

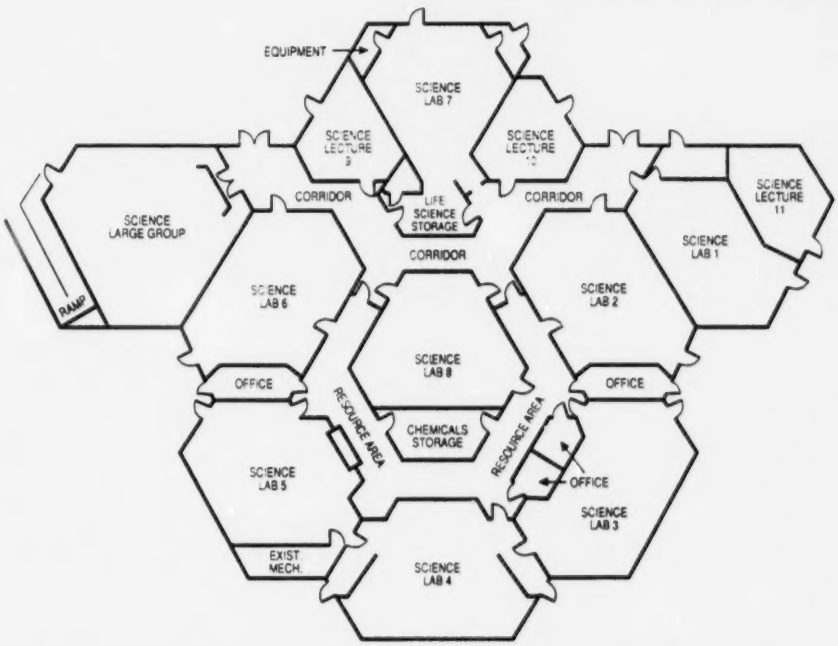


Fig. 28. Irvine High School Science Complex

Irvine High School, Irvine Unified School District. Adapted from a floor plan developed by Trittipo and Associates Architects. Reprinted with permission from John R. Trittipo, Architect, Trittipo and Associates Architects; and from Irvine High School. (See also figures 37 and 38 on page 41.)

computer facilities, if any (Science students and teachers frequently use reference materials, including microfiche, periodical literature, encyclopedias, and technical journals that would feasibly be located in a library or media center. These persons are also frequent users of computers and provide leadership in creative planning for computer use.)

- Selected proximity to other subject areas where combined or cooperative programs are planned; for example, environmental studies with the social studies and consumer and family studies departments, electronics program with industrial arts, cooperative vegetable garden with consumer and family studies, and cooperative use of the site computers with mathematics
- Separate air conditioning or ventilating systems or both to avoid circulation of fumes to other areas (Continuous operation of cooling, heating, and air conditioning systems to include summer, winter, and spring vacations may require special considerations for electricity in areas for growing plants, raising animals, and storing chemicals.)
- The safety and security of science materials and equipment
- Ease of delivery of supplies to the science storage or preparation areas; transport of equipment, chemicals, and so forth from one science area to another; and temporary storage and disposal of hazardous wastes (The science facilities would best be located on one level, preferably the ground level. For multilevel facilities, elevators should be provided for access by the disabled and transfer of equipment.)

Configuration of the Science Complex

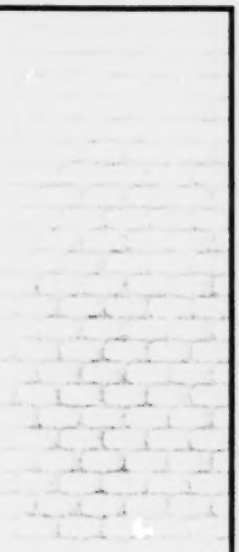
The community and the architect will often have strong considerations regarding the overall aesthetic effect of the plan and the place of each component. Function and efficiency should not be compromised; however, the best balance between function and aesthetics needs to be explored. A creative architect will use the functional aspects to enhance the aesthetics.

The configuration of the science complex should facilitate:

- Sharing equipment, space, and resources
- Communicating among science staff
- Using paraprofessional personnel
- Resolving unique problems caused by the size of the school campus

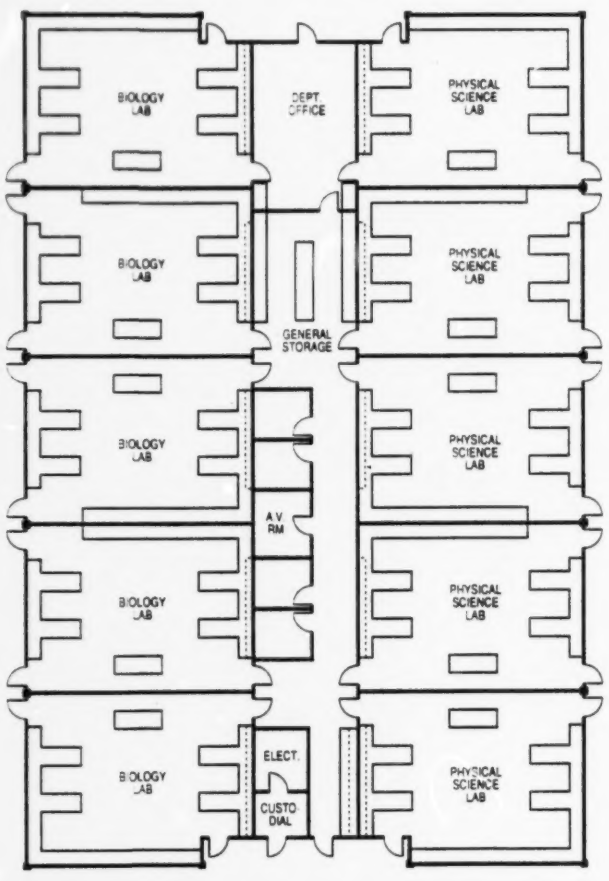
Sharing Equipment, Space, and Resources

Much of the equipment designed for teaching high school physics also has uses and applications in biology, chemistry, and earth/space science. Multiple uses are possible because most science applications combine knowledge from more than one area of science; for example, biochemistry, biophysics, molecular biology, and astrophysics. This trend makes apparent the advisability of having a central preparation or storage area with a pool of equipment that may be shared by all. This arrangement, however, *does not* suggest that *all* equipment should be purchased with shared use in mind and located in a central area.



A creative architect will use the functional aspects to enhance the aesthetics.

Some items of equipment are used almost exclusively in life science laboratory/classrooms (for example, autoclaves, anatomical models, video camera with microcapabilities, and physiological monitoring systems) and would be purchased in quantities necessary for shared use in those rooms and reserved for such use. Still other items are used so frequently that they should be purchased for and remain in specific laboratory/classrooms; for example, microscopes in biology and balances of various types and quantities in any laboratory/classroom. Computers with printers have broad classroom/laboratory applications that can be enhanced by a modem.



Rancho Bernardo High School, San Diego, Poway Unified School District. Adapted from a floor plan developed by Deems Lewis McKinley, San Diego. Reprinted with permission from John C. McKinley, President, Deems Lewis McKinley.

Fig. 29. A Floor Plan That Facilitates Communication and Cooperation Among Science Staff

Communicating Among Science Staff

Enhanced communication can be greatly facilitated by the physical relationships of the laboratory/classrooms and other departmental areas. Among the desirable characteristics to be promoted for communication are:

- Cooperative planning when two or more on a staff teach the same course, especially when implementing new programs
- A central location where all science teachers either gather or pass by for the posting or display of important announcements from the site and district and information for professional growth
- Easy access of staff members to all laboratory/classrooms to observe exemplary lessons or teaching techniques without interrupting the classroom learning activities
- Access to a professional library that may include school-purchased as well as individually purchased resource books, periodicals, curriculum guides, catalogs of equipment and materials, relevant research reports, and catalogs from graduate schools
- Availability (via computer) of chemical data bases, including inventories and specific hazards
- Access by first-year and second-year teachers to resource persons for special assistance and consideration

- Opportunities to share and observe science research projects of individual teachers

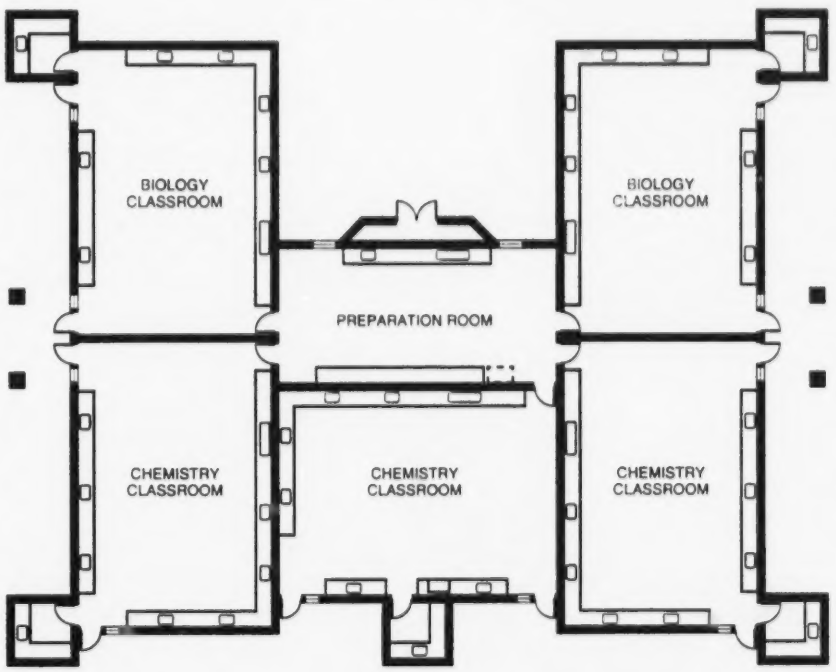
Using Paraprofessional Personnel

Science paraprofessionals are important resources to any science department and should be used to improve the total science instructional program. Accessibility of such paraprofessionals as teachers' aides and laboratory technicians, as well as secretarial and clerical staff, for each teacher is vital to maintaining a high quality program. Prioritizing the activities of these personnel to meet the staff's individual needs most effectively and ensure the timely completion of ongoing, routine activities should be the responsibility of an experienced staff member.

Forethought about providing paraprofessionals and student assistants with a suitable work area that will not interfere with classroom instruction will preclude the often-mistaken notion that the chemical storeroom is "acceptable" office space.

Planning Based on a School's Size

One of the initial considerations in planning the configuration of the science area is total student enrollment. Once the number of present and future laboratories/classrooms has been determined, along with the number and type of auxiliary areas needed, planning can proceed.



Serra Senior High School, San Diego San Diego City Unified School District. Adapted from a floor plan developed by Philip K. Markham, AIA, and Associates, San Diego. Reprinted with permission from the San Diego City Unified School District.

Fig. 30. Science Laboratory Addition

Alternative Room Layouts—Laboratory/ Classroom Configurations

The overall design of the science complex will be affected by the configuration of the laboratory/classroom, the dimensions of which will in turn be influenced by the type of furnishings (see Chapter VIII "Furnishings and Appliances"). The furnishings and configuration will be determined by use and vary from one science discipline to another. It may be desirable to increase the flexibility of the laboratory/classroom's use by adopting a uniform plan throughout, with relatively minor differences as required within science disciplines.

Configurations of laboratory facilities can be adapted to fulfill a wide variety of instructional needs. However, basic architectural plans in the early 1990s generally include either the perimeter-style, one of several island arrangements, or one of three peninsular arrangements to accommodate four, eight, or twelve students. A fourth basic configuration delineates separate areas for laboratory and nonlaboratory activities. This configuration may incorporate elements from perimeter, island, or peninsular configurations in the laboratory area. Diagrams of each of these basic configurations, as used for nonlaboratory and full-laboratory activities, are shown in this chapter. Commentaries on each example appear in the sections that follow.

Perimeter Laboratory Stations

Suggested specifications for perimeter laboratory stations, four students per station, follow:

- Counters, 36 inches (91.4 cm) high and 27 to 30 inches (68.6 to 76.2 cm) wide (with furring for pipe chase, if necessary, included), with lockable cabinets or drawers underneath (In this statement *furring* means "placement of a base cabinet four inches away from the wall, with material to hold space for the pipe chase." *Pipe chase* is a recess, for example, between a cabinet and the wall, within a cabinet, or between the ceiling and the roof for the passage of pipes.)
- Countertops that are resistant to heat and chemicals (for example, resin tops)—special provisions where chemicals are to be used extensively
- Stainless steel sinks, 12 x 14 x 7 inches (30.5 x 35.6 x 18 cm) deep at 9 feet (2.7 m) (minimum) on center with adjacent duplex gas and electrical outlets, one sink per four students
- At least one vertical under-counter section of 15 to 20 inches (38.1 to 50.8 cm) wide,

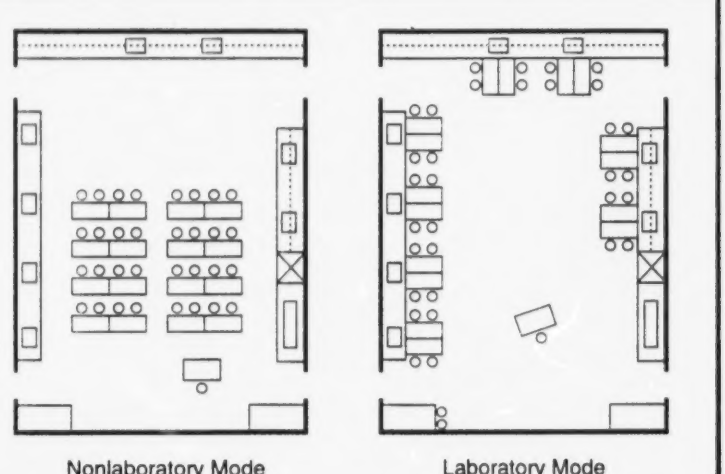


Fig. 31. Perimeter Arrangement

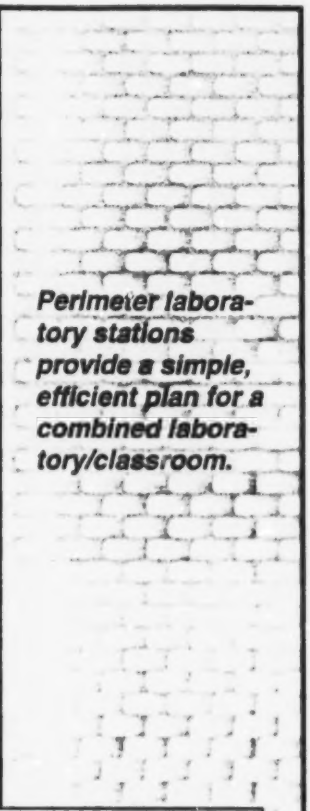
with lockable drawers of various sizes

- Over-counter wall storage cabinets as feasible, starting about 18 inches (45.7 cm) above the counter, to a height of 7 feet (2.1 m); 12 to 15 inches (30.5 to 38.1 cm) deep
- Lockable storage cabinet, 2 feet (.6 m) deep x 4 feet (1.2 m) wide x 7 feet (2.1 cm) high, with adjustable shelves
- Lockable display case, 2 feet (.6 m) deep x 4 feet (1.2 m) wide x 7 feet (2.1 m) high, with glass doors and adjustable shelves; the lower 2 feet (.6 m) to be lockable drawers

Optional features include:

- Stainless steel cleanup sink, 3 feet (.9 m) long (minimum) x 14 inches (35.6 cm) wide x 8 inches (20.3 cm) deep with hot and cold water
- Teacher's island, 2 feet (.6 m) x 2 feet (.6 m) x 36 inches (91.4 cm) high, with two duplex gas outlets, two duplex electrical outlets, stainless steel sink, and hot and cold water (This facility may also serve four or eight students for laboratory activities. See Figure 46 in Chapter VIII.)
- Portable fume hood
- Transparent protective screen (for teachers' demonstrations) against splashes and projectiles that is easily stored or concealed

Perimeter laboratory stations provide a simple, efficient plan for a combined laboratory/classroom (see Figure 31).



Perimeter laboratory stations provide a simple, efficient plan for a combined laboratory/classroom.

Advantages of Perimeter Laboratory Stations

The advantages of perimeter laboratory stations are as follows:

1. This station is more usable in a smaller classroom area than are other configurations and can be adapted for use in long, narrow, or square spaces.
2. The room is flexible because usually only the perimeter contains nonportable components, and students and tables can be arranged in various ways for various nonlaboratory activities.
3. A great deal of classroom storage can be included in base cabinets, wall cabinets, and special-purpose cabinets and display cases.

Disadvantages of Perimeter Laboratory Stations

The disadvantages of perimeter laboratory stations are as follows:

1. Because much of the wall space contains built-in cabinetry, space for chalkboards, tackboards, and places to locate doors is hard to find.
2. Unless a teacher's island is added to the front of the room, one of the student sinks at the perimeter would need to be used as a source of water, gas, and electricity for teachers' demonstrations, a condition less favorable than in other configurations.
3. Utility lines, including those for gas, water, and waste, must lead to and from at least two and probably three of the walls.
4. Because students are separated along the perimeter, supervision during laboratory activities is more difficult.
5. In the laboratory mode two tables for two students are to be brought adjacent to each sink for work space so that each sink will accommodate four students; therefore, a greater number of sinks are required than for most other configurations.

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Fig. 32. Island Arrangement

Island Laboratory Stations

Suggested specifications for island laboratory stations, twelve students per station, are as follows:

- Hexagonal islands, 36 inches (91.4 cm) high, approximately 48 inches (121.9 cm) across the island from face to face, with one sink (14 x 14 x 7 inches [35.6 x 35.6 x 17.8 cm] deep), three faucets, three duplex electrical outlets (on the sides), and three duplex gas outlets
- Countertops resistant to heat and chemicals
- A length of counter along one wall with cabinets under and over and with duplex electrical outlets and duplex gas outlets at 6 feet (1.8 m) on center
- At least one vertical under-counter section 15 to 20 inches (38.1 to 50.8 cm) wide, with lockable drawers of various sizes
- Teacher's island, 2 feet x 2 feet x 36 inches (.6 m x .6 m x 91.4 cm) high, with two duplex gas outlets, two duplex electrical outlets, stainless steel sink, and hot and cold water (See Figure 46.)
- Lockable storage cabinet, 2 feet (.6 m) deep x 4 feet (1.2 m) wide x 7 feet (2.1 m) high and with adjustable shelves
- Lockable display case, 2 feet (.6 m) deep x 4 feet (1.2 m) wide x 7 feet (2.1 m) high, with glass doors and adjustable shelves; the lower 2 feet (.6 m) are to be lockable drawers

Utility lines to islands may be laid in trenches (in concrete floors).

Optional features include:

- Stainless steel cleanup sink in counter, 3 feet (.9 m) long (minimum) x 14 inches (35.6 cm) wide x 8 inches (20.3 cm) deep with hot and cold water
- Portable fume hood

Island laboratory stations also provide a simple, efficient plan for a combined laboratory/classroom (see figures 32 and 33).

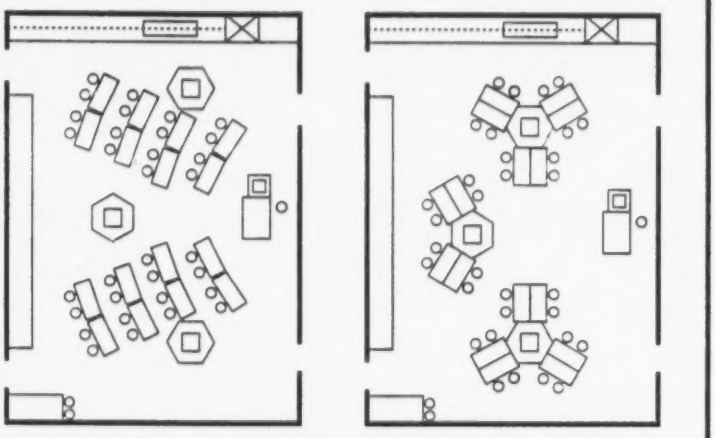
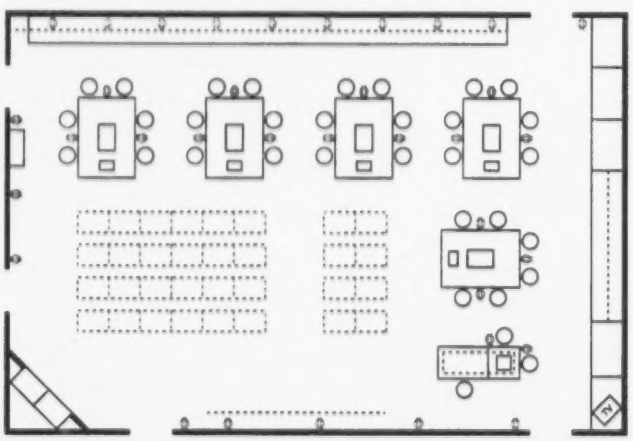


Fig. 33. Island Arrangement from the Los Angeles Unified School District



Adapted from a floor plan developed for the Los Angeles Unified School District. Reprinted with permission from the Los Angeles Unified School District.

Advantages of Island Laboratory Stations

The advantages of island laboratory stations are as follows:

1. Because laboratory stations are arranged toward the central portion of the room, supervision of laboratory activities is facilitated.
2. Wall space to locate whiteboards, tackboards, and doors is generally available.
3. Because six tables for two students can be moved adjacent to each hexagonal island for work space, fewer sinks are required.
4. A room is easily converted to and from a laboratory mode.
5. Water, gas, and electricity are generally available to students in nonlaboratory modes.

Disadvantages of Island Laboratory Stations

The disadvantages of island laboratory stations are as follows:

1. Islands may obstruct visibility and movement during nonlaboratory activities.
2. Larger rooms are generally required to ensure that students need not interfere with one another during laboratory activities.
3. This configuration is not well suited to a long, narrow space.

Peninsular Laboratory Stations

Variations of the peninsular laboratory arrangement are for four, eight, and twelve students. A description of each follows.

Four-student Peninsular Stations

Suggested specifications for four-student peninsular laboratory stations are as follows:

- Approximately rectangular peninsulas, 36 inches (91.4 cm) high, 40 inches (101.6 cm) wide (may be slightly wider at the juncture with a wall counter and slightly narrower at the free end), 54 inches (137.2 cm) long, extending out from perimeter counters 2 feet (.6 m) wide, a minimum of 9 feet (2.7 m) on center; one peninsula per four students
- Stainless steel sinks, 12 inches (30.5 cm) x 14 inches (35.6 cm) x 6 inches (15.2 cm) deep, with two faucets and duplex gas and electrical outlets (The sinks are to be near the juncture of the peninsula with the wall counter.)
- Countertops resistant to heat and chemicals
- Cabinets under and over adjacent perimeter counters, duplex gas and electrical outlets at 6 feet (1.8 m) on center
- Lockable storage cabinet, 2 feet (.6 m) deep x 4 feet (1.2 m) wide x 7 feet (2.1 m) high, with adjustable shelves
- Lockable display case, 2 feet (.6 m) deep x 4 feet (1.2 m) wide x 7 feet (2.1 m) high, glass doors with adjustable shelves; the lower 2 feet (.6 m) to be lockable drawers

Optional features as appropriate are as follows:

- Stainless steel cleanup sink, 3 feet (.9 m) long (minimum) x 14 inches (35.6 cm) wide x 8 inches (20.3 cm) deep with hot and cold water
- Portable fume hood

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Advantages of Four-student Peninsular Stations

The advantages of four-student peninsular laboratory stations are as follows:

1. Counter space is built in, and tables need not be relocated in moving between nonlaboratory and laboratory modes.
2. Classroom storage in base cabinets and over-counter cabinets can be readily available.

Disadvantages of Four-student Peninsular Stations

The disadvantages of four-student peninsular laboratory stations are as follows:

1. Much of the classroom space is taken up by the laboratory counters and cabinets; therefore, a somewhat larger room is necessary.
2. Utility lines, including those for gas, water, and waste, will most feasibly access to and from at least three and, probably, all four walls (although access from the ceiling or floor may be designed).
3. Supervision during laboratory activities is more difficult because students are separated along the perimeter.
4. Wall space for locating whiteboards, tackboards, bookcases, wall charts, specialized cabinetry, and doors may be at a premium.

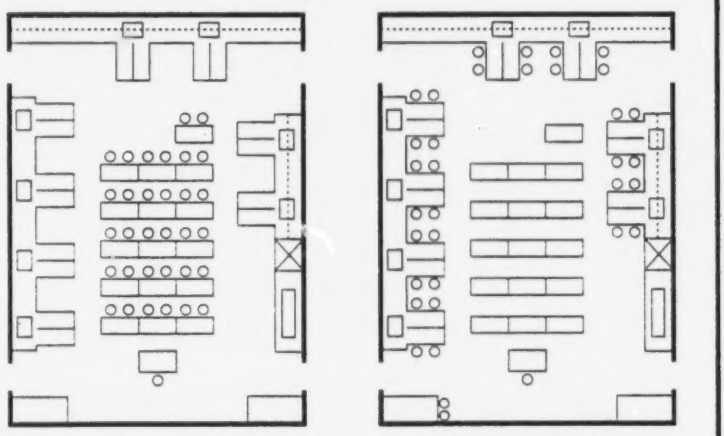

Fig. 34. Four-student Peninsular Arrangement

Four-student peninsular stations are functionally similar to perimeter stations (see Figure 34).

Eight-student Peninsular Stations

Eight-student peninsular stations should have:

- Rectangular peninsulas, 36 inches (91.4 cm) high, 40 inches (101.6 cm) wide, 54 inches (137.2 cm) long, extending out from 2 foot (.6 m) wide perimeter counters, 9 feet (2.7 m) on center minimum—one station per eight students (See Figure 35.)
- Stainless steel sinks, 12 x 14 x 6 inches (30.5 x 35.6 x 15.2 cm) deep, two faucets with duplex gas and electrical outlets on each side and near the end of the peninsula (Sinks are to be near the free end of the peninsula.)
- Countertops resistant to heat and chemicals
- Cabinets under and over adjacent perimeter counters, with duplex gas and electrical outlets at 6 feet (1.8 m) on center
- Lockable storage cabinet, 2 feet (.6 m) deep x 4 feet (1.2 m) wide x 7 feet (2.1 m) high, with adjustable shelves
- Display case, 2 feet (.6 m) deep x 4 feet (1.2 m) wide x 7 feet (2.1 m) high, with glass doors and adjustable shelves (The

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lower 2 feet [.6 m] are to be space for lockable drawers.)

- Stainless steel sinks, 12 x 14 x 6 inches (30.5 x 35.6 x 15.2 cm) located on adjacent perimeter counter as work space permits

Optional features as appropriate are as follows:

- Stainless steel cleanup sink, 3 feet (.9 m) long (minimum) x 14 inches (35.6 cm) wide x 8 inches (20.3 cm) deep with hot and cold water
- Portable fume hood

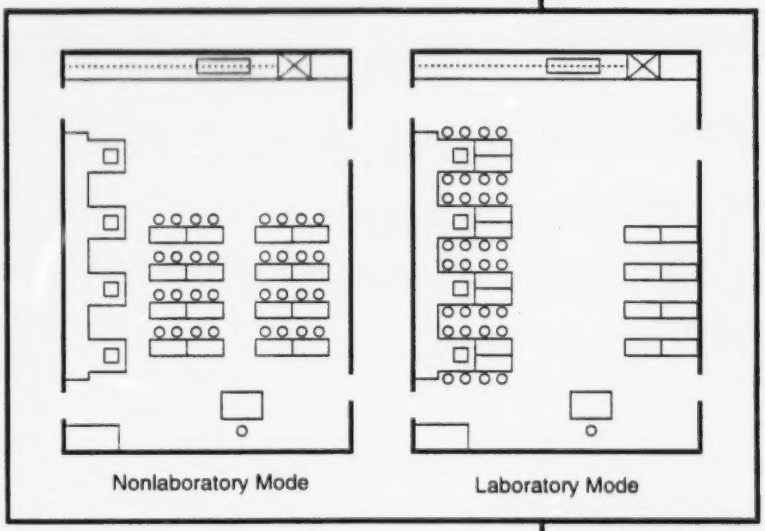

Fig. 35. Eight-student Peninsular Arrangement

Advantages of Eight-student Peninsular Stations

The advantages of eight-student peninsular laboratory stations are as follows:

1. Counter space for laboratory activities is partly built in, and only a portion of the tables need to be relocated in moving between nonlaboratory and laboratory modes.
2. Classroom storage in specialized cabinets, base cabinets, and over-counter cabinets can be readily available.
3. Eight students can use the utilities around one sink if two tables for two students are brought adjacent to the peninsula.
4. Supervision of laboratory activities is facilitated because students are located in one general area of the room.
5. All of the utilities services can be located along one wall, an arrangement which can accommodate use in a long, narrow space.
6. Wall space for whiteboards, tackboards, specialized cabinetry, and doors can be readily available.

Disadvantages of Eight-student Peninsular Stations

The disadvantages of eight-student peninsular stations are as follows:

1. Peninsulas may somewhat obstruct nonlaboratory activities.
2. A little more space should be planned than for a perimeter arrangement.

Twelve-student Peninsular Stations

Twelve-student peninsula stations should have:

- Enlarged, approximately hexagonal portions (containing the utilities) at the free end (Extending out about 88 inches [223.5 cm] from 2 feet [.6 m] deep perimeter counters, the peninsulas should be about 16 feet [4.8 m] on center. With

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student tables to supplement the work space, each peninsula can accommodate twelve students. See Figure 36.)

- Stainless steel sinks located in the center of the hexagonal portion, 14 x 14 x 7 inches (35.6 x 35.6 x 17.8 cm) deep, with three faucets, three duplex gas outlets on top near the sink, and three duplex electrical outlets, one each to be located on alternate faces of the hexagonal cabinet
- Countertops resistant to heat and chemicals (for example, resin tops)
- Cabinets under and over adjacent perimeter counters (Duplex gas and electrical outlets at 6 feet [1.8 m] on center [Additional sinks are to be located on the counter as appropriate.])
- Lockable storage cabinet, 2 feet (.6 m) deep x 4 feet (1.2 m) wide x 7 feet (2.1 m) high, with adjustable shelves
- Display case, 2 feet (.6 m) deep x 4 feet (1.2 m) wide x 7 feet (2.1 m) high, with tempered glass doors, and adjustable shelves (The lower 2 feet [.6 m] are to be space for lockable drawers.)

Optional features include:

- Stainless steel cleanup sink, 3 feet (.9 m) long (minimum) x 14 inches (35.6 cm) wide x 8 inches (20.3 cm) deep with hot and cold water
- Portable fume hood

Advantages of Twelve-student Peninsular Stations

The advantages of twelve-student peninsular stations are as follows:

1. Counter space for laboratory activities is partly built in, and only a portion of the tables need to be relocated in moving between nonlaboratory and laboratory instructional modes.
2. Classroom storage in specialized cabinets, base cabinets, and over-counter cabinets can be readily available.
3. Twelve students can have access to the utilities around one sink if four two-student tables are brought adjacent to the peninsula.
4. Supervision of laboratory activities is facilitated because students are located in one general area of the room.
5. All of the utilities services can be located along one wall, an arrangement which can facilitate use in a long, narrow space. This arrangement may have special favorable applications when a large area is being remodeled for science instructional use.
6. Wall space for whiteboards, tackboards, specialized cabinetry, and doors can be readily available.

Disadvantages of Twelve-student Peninsular Stations

The disadvantages of twelve-student peninsular stations are as follows:

1. Peninsulas may significantly obstruct visibility and movement during nonlaboratory activities.
2. A relatively large space is required.

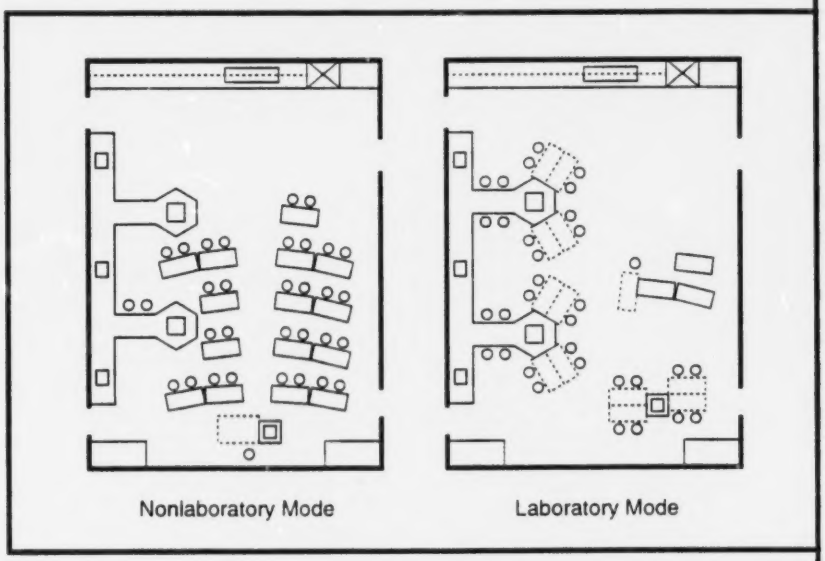


Fig. 36. Twelve-student Peninsular Arrangement

Nontraditional Designs

Numerous science facilities throughout California and the United States have creative, aesthetically pleasing, and functional designs. Such designs need not be very costly. The accompanying sketches are based on two of several laboratory/classroom arrangements that are part of the total science complex configuration of Irvine High School in the Irvine Unified School District (see figures 37 and 38.)

Figs. 37 and 38. Two of Several Laboratory/ Classroom Configurations in the Irvine High School Science Complex

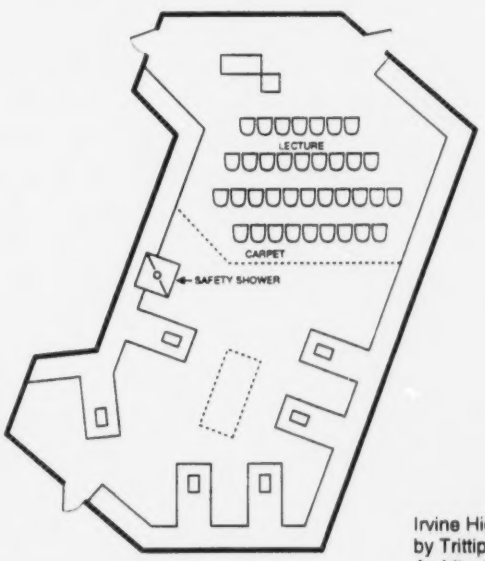


Fig. 37

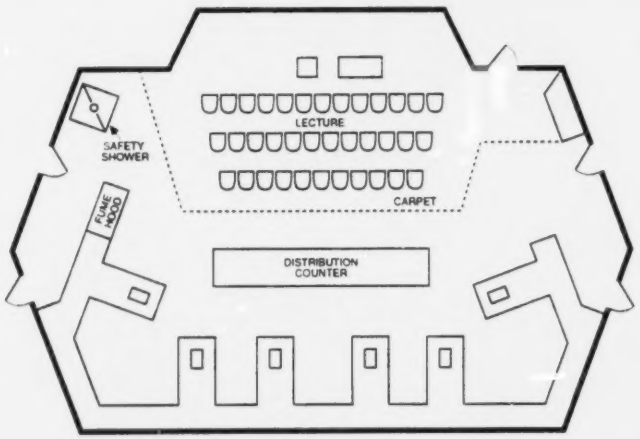


Fig. 38

Irvine High School, Irvine Unified School District. Adapted from a floor plan developed by Trittipo and Associates Architects. Reprinted with permission from John R. Trittipo, Architect, Trittipo and Associates Architects; and from Irvine High School. (See also Figure 28 on page 30.)

Preparation and Storage Areas

Ideally, there would be central preparation and storage areas, or a combined preparation/storage area, with ready access for teachers (and controlled access for students) from all classrooms[1] (also see the checklist in Appendix C). The National Science Teachers Association (NSTA) recommends that, for middle schools and high schools, the space for this area should "be separate from and equivalent to at least 15 percent of the laboratory space it services."[2] Recommendations for the preparation and storage areas follow:

- Adequate arrangements should exist for the safe storing and handling of any equipment or supplies used in the science program. (*Note:* To minimize corrosion of equipment, especially electronics, a separate chemicals storage room should be provided if significant quantities of hazardous chemicals are used.)
- Shelving should be fixed firmly to the walls and be provided with restraining lips to prevent materials from falling off during an earthquake.[3] The *Science Safety Handbook for California High Schools* contains a significant section related to earthquake preparation.
- Adequate space should be available to accommodate demonstration carts or laboratory carts being loaded for use in the classroom.[4]
- The area should be equipped to allow for safe mixing of chemicals, including the prompt removal of any undesirable fumes generated.
- Space may be included to accommodate desks for teachers' use during preparation periods as well as an area for meetings of small groups of teachers and for teachers' or students' conferences.[5]

In addition, teachers should have a place where they can prepare materials for student experimental work, set up and test demonstrations, and conduct research of their own. These areas may be part of, or separate from but adjacent to, the storage space. Storage areas should include special provisions for separate (and otherwise safe) storage of incompatible chemicals. (See "Establishing Safer Chemical Storage Areas" in the *Science Safety Handbook for California High Schools.*) Preparation or storage areas or combined preparation and storage facilities should have accessible:

- Sink(s) with water (preferably hot and cold) and exhaust hood over sink
- Counter space
- Electrical outlets
- Gas outlets
- Diffused lighting of 100 foot-candles at work level
- Lockable storage, which is vented to the outdoors, for special corrosive chemicals, preferably with separate areas for acids and bases
- Lockable storage, which is vented to the outdoors, for special flammables
- Lockable storage for poisons
- Separate safe storage for incompatible chemicals such as:

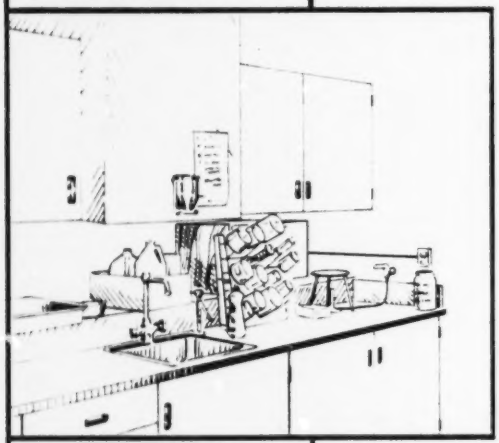


Fig. 39. The preparation area should be equipped to allow for safe mixing of chemicals, including a vent for prompt removal of undesirable fumes.

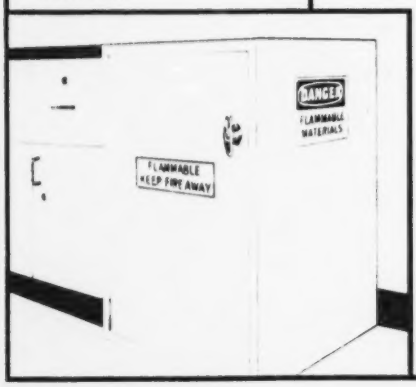


Fig. 40. Provisions for separate storage of a variety of chemicals are necessary.

1. Oxidizers
2. Metals
3. Ammonium nitrate
4. Nitric acid
5. Flammable and nonflammable compressed gases
6. Low-hazard chemicals

- Earthquake-safe storage throughout with cabinets and shelves anchored to structural support, including restraining lips and wires on shelving and secure latches on cabinetry
- First-aid kit
- Fire extinguisher
- Fire blanket
- Plastic waste receptacles and designated hazardous waste receptacles
- Chemical spill kit and absorbant spill pillows
- Chemical inventory system, including material safety data sheets (MSDS) (Computerization should be anticipated for this system.)
- Storage for apparatus, glassware, and equipment
- Exit to hall or outdoors (All doors should be self-closing and lockable.)
- Eyewash station and safety shower (or combination)
- Fume hood
- Adequate ventilation (continuous and separate where chemicals are stored), including purge system
- Computer area for teachers' use, networked with classroom computers as feasible

An illustration from the *Science Safety Handbook for California High Schools* of a combined preparation/storage area is reprinted in Appendix C.

Accessory Rooms to Support Science Programs

Other than the laboratory/classrooms, the minimum additional requirements are storage or preparation areas or a combined storage and preparation area that is properly ventilated. Depending on the program's needs and available funds, other resource areas should include:

- Chemicals storage facility/vault with corrosion-proof counter, hooded sink, constant temperature, and continuous air exchange system
- Student project rooms for independent and small-group research (One room per laboratory/classroom or shared by two laboratory/classrooms is recommended. The dimensions should be about 125 to 175 square feet [11.3 to 15.8 m^2] [larger if the room is to be shared] with counters [including one for computer and accessories], sink, gas, electricity, and storage cabinets under and over the counter.)
- Darkroom—80 to 150 square feet (7.2 to 13.5 m^2)
- Plant-growing facility or alternatives such as:
  1. Commercially available environmental chamber, approximately 20 square feet (1.8 m^2) with shelves
  2. Plant growth room (a minimum of 100 square feet [9 m^2]) with shelves, special lighting, concrete floor with drain, and a faucet with an adaptor for a hose

Other than the laboratory/classrooms, the minimum additional requirements are storage or preparation areas or a combined storage and preparation area that is properly ventilated.

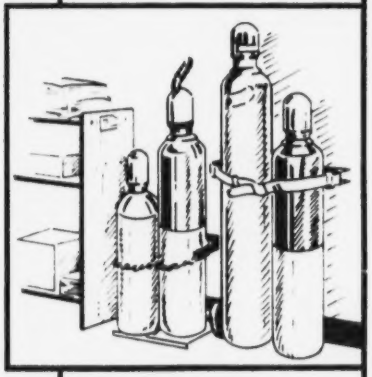


Fig. 41. Safe storage of compressed gasses cylinders includes replacing the cylinder cap and strapping or chaining the cylinders securely in an upright position.

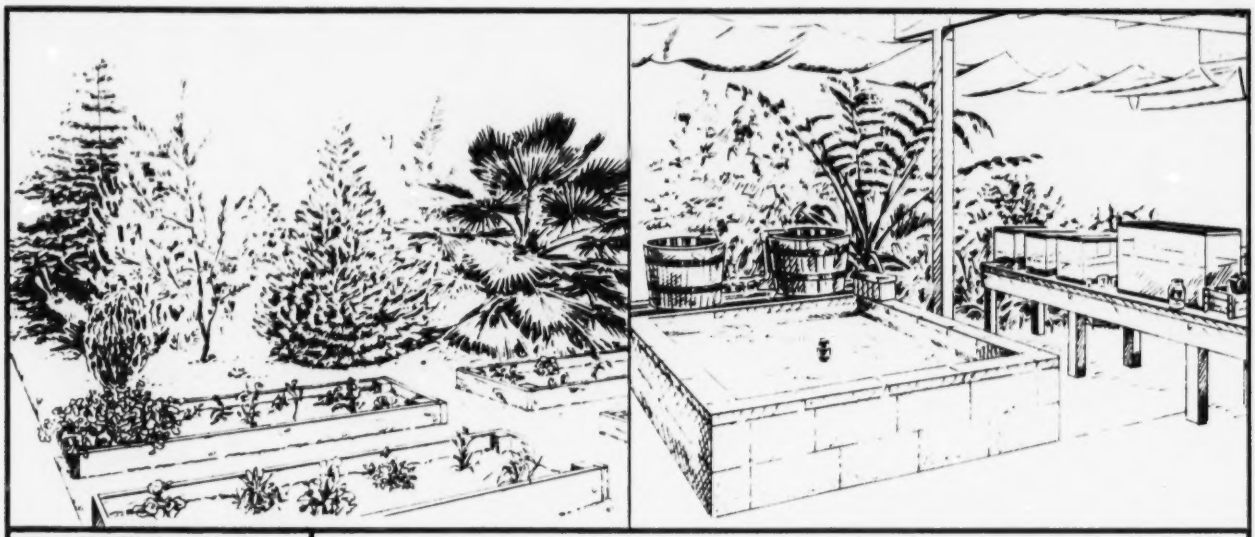


Fig. 42. An outdoor growing area with a pond can be used for a wide variety of environmental studies and for production of many of the specimens necessary in biological studies.

3. Greenhouse, minimum of 400 square feet (36 m^2), with appropriate solar exposure
4. Outdoor growing area, preferably with pond for environmental studies, with appropriate solar exposure (Such an area is very useful if low temperatures are not a problem.)

- Facility for the study of animals or alternatives such as:
  1. Commercially available environmental chamber, approximately 20 square feet (1.8 m^2) with shelves
  2. Room for the study of animals, 150 square feet (13.5 m^2) minimum with counter, sink, cabinets over and under, the sink faucet with an adaptor for a hose, and a floor drain
- Combined facility for plants and animals
- Conference or seminar room, minimum one per department, 100 square feet (9 m^2 or 15 square feet (1.4 m^2) per student
- Planning area for teachers, a minimum of 50 square feet (4.5 m^2) per professional

For the purposes of this document, adequate detail has been provided previously for student project rooms, a darkroom, plant and animal facilities, a conference or seminar room, and planning areas for teachers as may be included in the complex. These areas, presumably, would be accessible to the science facilities; and appropriate lighting, ventilation, whiteboards, and tackboards would be provided as well as normal amenities for their special uses.

Utilities and Miscellaneous Items

Each room, wall, counter, cabinet, and appliance to be used should be considered separately and creatively as plans are developed for placement of utilities. The following are basic needs:

- Electrical facilities
  1. Ground fault interrupters are to be provided throughout to protect personnel from shock, and surge protectors are needed to protect instruments from unexpected electrical surges.

2. One duplex electrical outlet should be provided for each station for four students. An alternative for perimeter arrangements is a plug mould with outlets at 18 or 24 inches (45.7 or 61 cm) on center.
3. Duplex outlets should be provided along the walls (a minimum of 6 feet [7.8 m] at counter workspace and 8 feet [2.4 m] on center) on those walls not containing cabinets.
4. Locations and arrangements for utilities where water or chemicals may be easily spilled on outlets should be avoided; for example, outlets should never be installed horizontally on countertops.
5. One master electrical panel for the room is to be located near the teacher's station and as near an exit as possible.
6. Electrical service must be planned in preparation, storage, and classroom areas wherever electrical appliances are to be placed; for example, refrigerator, fume hood, display case, and goggles sanitizer.
7. Two duplex electrical outlets should be provided at the teacher's station and one or more at the teacher's preparation area and in the storeroom.

- Flooring
  1. Hospital grade seamless resilient flooring or its equivalent should be installed in areas where chemicals may be spilled. This flooring is nearly impervious to damage from typical school science chemicals.
  2. Carpets are not recommended because they may hamper cleanup operations and deteriorate from chemical spills, producing toxic fumes in the process.
- Natural (or bottled) gas
  1. One duplex gas outlet should be provided per four students at the work stations, two at the teacher's station, and one or more at the teacher's preparation area and in the storeroom.
  2. One master gas shut-off valve should be provided, located near the teacher's station and as near an exit as possible.
- Plumbing
  1. Acid-resistant waste lines should be installed throughout.
  2. Lines of sufficient diameter should be installed to ensure that the unique needs of the science laboratory are met. Except for lines from individual sinks, which may be 2-inch (5.1 cm) lines, the size of the lines used to convey the waste should be 3 inches (7.6 cm) (minimal) and preferably 4 inches (10.2 cm).
  3. Vendors' deliveries of plumbing materials, such as sinks, faucets, and gas outlets, for science classrooms are frequently very slow. Persons planning the facilities should coordinate with the architect to ensure that these items are identified and ordered as far ahead of the actual need as possible.
  4. The diameter of pipes that lead to and drain from the deluge shower need special consideration because of higher than normal gallonage requirements.

Lines of sufficient diameter should be installed to ensure that the unique needs of the science laboratory are met.

- Sinks
  1. Dimensions vary with use (see the perimeter arrangement in Figure 31; the island arrangements in figures 32 and 33; the student peninsula arrangements in figures 34, 35, and 36; and the descriptions of sinks for these configurations).
  2. The material should be of heavy-gauge stainless steel.
  3. Antisiphon faucets should be used.
  4. The minimum size for cleanup sinks is 3 feet (.9 m) long x 14 inches (35.6 cm) wide x 7 inches (17.8 cm) deep. The sinks should be constructed of heavy-gauge stainless steel or fabricated from an appropriate synthetic material. They should have antisiphon faucets with hot and cold water. Sinks are to be located on a wall counter, and they may be used also as a student laboratory station.

CHAPTER VIII

FURNISHINGS AND APPLIANCES

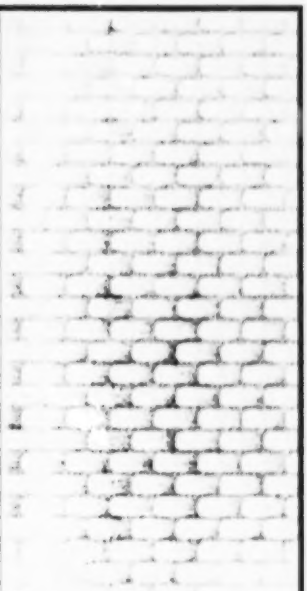
In this publication the furnishing of a laboratory/classroom refers to all of the built-in structures such as storage cabinets, counters, laboratory stations, utilities, exits, ventilation systems, tables, chairs, and safety features. *Furnishing* does not, in general, include science apparatus, equipment, supplies, and books, requirements for which are determined by the curriculum or course offerings.

A laboratory/classroom's furnishings will vary, at least somewhat, depending on the courses that the facilities are expected to accommodate.

Basic Requirements for Furnishings

Typical features of science facilities for elementary schools, middle schools, and high schools were discussed in chapters IV, V, and VI. For the most part, however, consideration should be given to providing the following basic requirements (see also the checklist in Appendix B), especially for *any* laboratory/classroom where more than one science discipline may be taught:

- Lockable storage space for apparatus and supplies that are regularly used, including at least one small section of lockable drawers
- Smooth, unobstructed, level laboratory work space (NSTA recommends 1 square meter [10.7 square feet] per student.)[1]
- Diffused lighting of 100 foot-candles at the work area (Task lighting may be used effectively for laboratory activities.)
- Laboratory stations (one designed for use by the disabled), arranged so that each team of two students can have ready access to:
  1. Work space
  2. Water source and drain
  3. Electrical outlet
  4. Gas outlet
- A teacher's demonstration station, which may double as a student's laboratory station, including:
  1. Work space
  2. Source for hot and cold water and a drain
  3. Two duplex electrical outlets
  4. Duplex gas outlet
  5. Fume hood for demonstrations
- Safety features necessary in case of emergencies are as follows:
  1. An eyewash station with necessary plumbing at a maximum distance of 25 feet (7.5 m) from any point in the room[2] (For example, one station may be in a central location or where chemicals are



A laboratory/classroom's furnishings will vary, at least somewhat, depending on the courses that the facilities are expected to accommodate.

most likely to be used, or two stations may be at opposite ends of the room. Two stations are recommended for chemistry rooms.)

2. An emergency deluge shower in chemistry rooms and in chemical preparation areas when corrosives are used or handled (See *California Code of Regulations, Title 8, Public Employment Relations Board,* Section 5191.)
3. A fire blanket (100 percent wool) and an ABC fire extinguisher (Both should be near an exit for accessibility from within the room or on entering.)
4. A master gas shut-off valve and master electrical shut-off switch (If any individual water shut-off valves are inaccessible, a master water shut-off valve should be provided.)
5. A sanitizer and storage cabinet for goggles
6. Adequate ventilation (If windows cannot be opened, a mechanical exhaust purge system capable of replacing room air with outside ambient air within 3 to 5 minutes should be installed for emergency use in addition to air-conditioning systems.)
7. A smoke/heat detector
8. No blind spots that cannot be monitored by the teacher from any location in the room

- Lockable enclosed display case (It should be near the entrance so that interesting items may be visually accessible to all students.)
- Tackboards (bulletin boards) 8 to 16 linear feet (2.4 to 4.8 m)
- Whiteboards (dry-erase boards) 16 to 24 linear feet (4.8 to 7.2 m) (A type of board that would also serve as an audiovisual screen should be considered.)
- An audiovisual screen and room darkening capabilities; for example, special blinds or curtains, if necessary
- A teacher's desk and chair
- File, five-drawer, letter size, with lock
- Table, 22 x 54 x 30 inches (55 x 137.2 x 76.2 cm) high, with top resistant to heat and chemicals (One per two students should be available.)
- Student's chair, one per student
- Tablet armchairs (one per student) (These may substitute for chairs and tables if all laboratory activities are done at available counter space.)
- Portable table for science demonstrations, 36 inches (91.4 cm) high
- Stock cart 30 x 16 x 36 inches (76.2 x 40.6 x 91.4 cm) with 5 inch (12.7 cm) metal wheels
- Bookcase

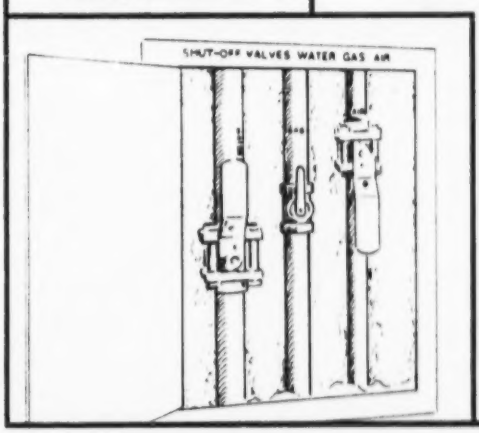


Fig. 43. Master controls for gas, electricity, and water should be located for emergency use and be clearly identifiable.

Suggested Specifications for Laboratory/ Classroom Components

Counters for student work space should be durable and at comfortable and functional levels. The following should be considered in the design for accessible storage and display of

instructional materials in base and wall cabinets:

- Work counters with cabinets underneath (For base cabinet detail see Figure 44.)
  1. Dimensions: height 36 inches (91.4 cm), depth 27 to 30 inches (68.6 to 76.2 cm) (includes 4 inches [10.2 cm] furring and a passageway for utility lines, length as appropriate)
  2. Cabinetry under the counter to be divided into cabinets with one adjustable shelf and lockable doors
  3. At least one section 15 to 20 inches (38 to 50.8 cm) wide located under the counter and provided with lockable drawers (A preferable location for these drawers is near the teaching station.)
  4. Duplex electrical outlets at 6 feet (1.8 m) on center
  5. Duplex gas outlets at 6 feet (1.8 m) on center
  6. Countertops resistant to heat and chemicals and with 2 inches (5.1 cm) overhang (Special attention should be given to ensure that plastic-laminated tops are well sealed so that moisture does not intrude and cause swelling and separation. Resin, stone, or stone-like tops are more expensive but preferable.)
  7. Toe space inset at base
  8. Two metal-lined holes at each laboratory station with compatible 12 to 18 inch (30.1 to 45.7 cm) metal rods for attachment of clamps or rings

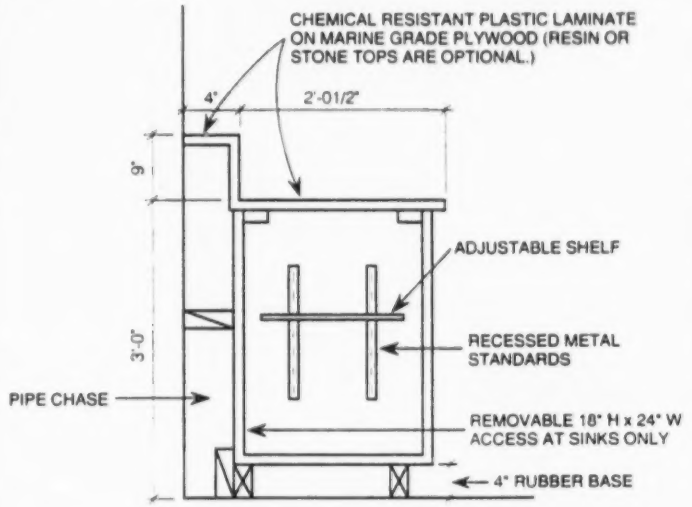


Fig. 44. Cross Section of Base Cabinet Detail

- Over-counter wall cabinets (For over-counter wall cabinet detail, see Figure 45.)
  1. Dimensions: 30 inches (76.2 cm) high x 12 to 15 inches (30.1 to 38.1 cm) deep x length as appropriate
  2. Bottom of cabinet to be 18 inches (45.7 cm) above the counter
  3. Lockable hinged or sliding wood doors or sliding glass (tempered) windows on front

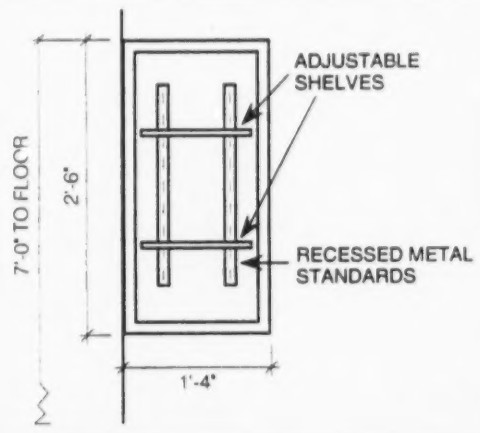


Fig. 45 Cross Section of Wall Cabinet Detail

4. One adjustable shelf

- Teacher's demonstration table or island
  1. *Option 1:* 36 inches (91.4 cm) high, large (up to 4 x 9 feet [1.2 x 2.7 m]) stationary surface with cabinets and drawers underneath
  2. *Option 2:* 36 inches (91.4 cm) high x 2 feet x 2 feet (.6 m x .6 m) island (The teacher may roll a demonstration table adjacent to this island in order to perform demonstrations, or students may bring their tables beside it, providing additional laboratory space [see Figure 46].)
  3. Stainless steel sink with an antisiphon faucet and hot and cold water (The size may be variable according to preferences. For example, a sink 14 x 16 x 6 inches [35.6 x 40.6 x 15.2 cm] deep may be used for option 1; (or a sink 1 foot x 1 foot x 6 inches [.3 m x .3 m x 15.2 cm] deep may be used for Option 2).
  4. Top resistant to heat and chemicals (for example, plastic laminate or resin tops)
  5. Two duplex electrical outlets on opposite faces of vertical cabinetry immediately underneath the countertop
  6. Two duplex gas outlets on top
  7. Metal-lined holes with compatible 12 to 18 inch (30.5 to 45.7 cm) metal rod for attachment of clamps or rings

Fig. 46. Teacher's Island

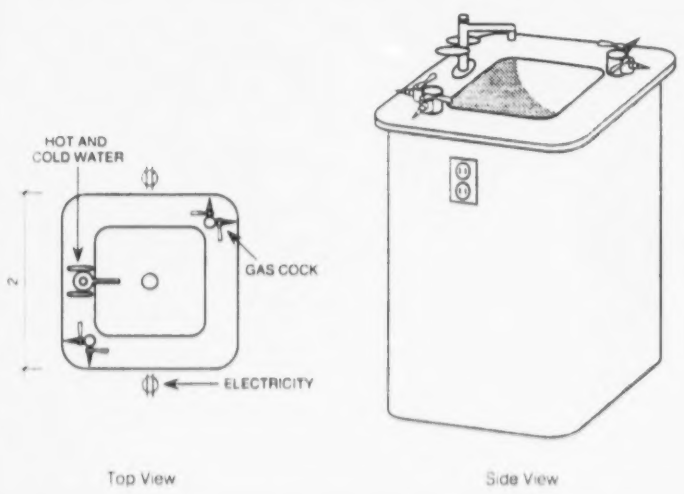
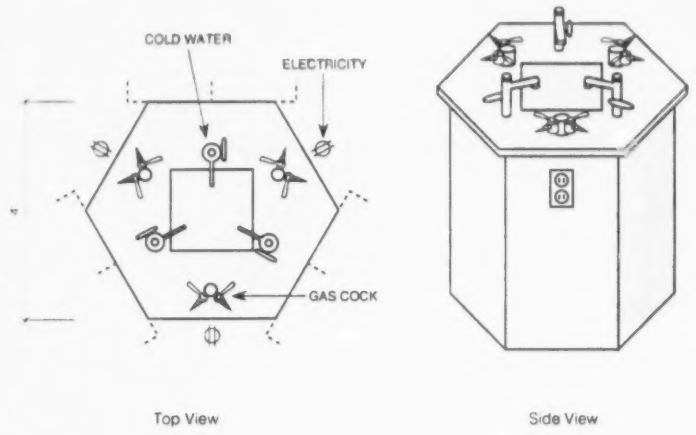


Fig. 47. Hexagonal Student Island



The hexagonal island laboratory station that will accommodate 12 students when arranged with students' laboratory tables for work space is shown in Figure 47. (See "Island Laboratory Stations" in Chapter VII for additional information.)

Appliances

In the science facility it is often difficult to distinguish between equipment and appliances. The following appliances, which may be

located either in the classroom or in the storage or preparation area, have special characteristics:

- Specifications for a fume hood
  1. Average face velocity of 100 linear feet (30 m) of air per minute at the opening with a minimum of 70 linear feet (21 m) at any position of the velometer
  2. Placement so that air currents do not draw fumes from fume hoods into the room
  3. A standpipe extending 7 feet (2.1 m) above the roof and located so that exhaust fumes will not be drawn into windows or roof-mounted air intakes
  4. Standpipes constructed of corrosion-resistant materials and designed to prevent rain from entering (Local fire codes must be checked for standpipe specifications.)
  5. Nonsparking motor, switch, and installation
- Germicidal, ultraviolet sanitizer for goggles: Needs to be located in places readily accessible to classrooms as well as to storage or preparation areas (Goggles sanitizers are for sterilizing and storing goggles.)
- Lockable, explosion-proof refrigerator: Needs to be a safety model with a sparkproof motor and nonsparking switches (The refrigerator should be designed to be hard-wired directly into the alternating current to avoid the possibility of sparking at the outlet during routine plugging in and unplugging.)

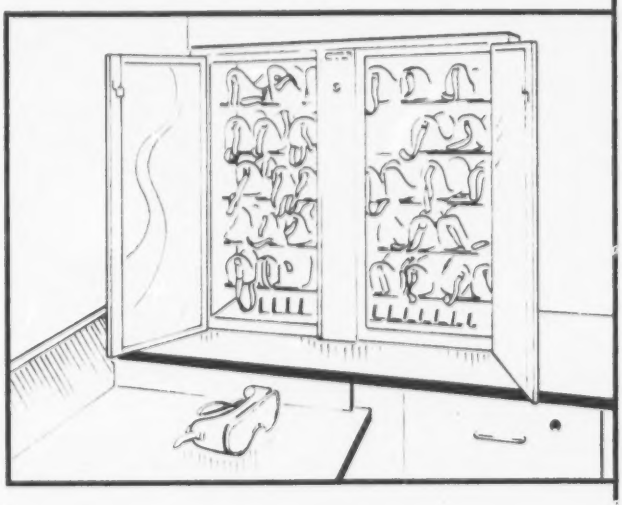


Fig. 48. Goggles sanitizers also provide storage for goggles.

CHAPTER IX

Costs

Estimates of costs appearing in this publication provide at best a rough guideline. However, if they are updated and are combined with other costs obtained locally, a realistic budget for science facilities might be estimated. As previously stated, the *California Code of Regulations, Title 2, Administration*, Section 1811(g)(2), requires state architects to design for occupancy of 24 students in grades nine through twelve or 26 students in grades seven through twelve. These design specifications are generally understood by state and local agencies to be equivalent to 1,300 square feet (117 m^2) of floor space, *including preparation and storage space*. The state allowance for constructing such facilities is shown in the following table:

State Allowance for Constructing Facilities

Type of construction	*General science classroom (biology)*	*Laboratory (physics, chemistry)*	*Additional multiplier (fluctuates monthly)*
Class B (reinforced concrete frame)	$85.98 per sq. ft.	$177.33 per sq. ft.	$1.09 per sq. ft.
Class D (wood frame)	$82.91 per sq. ft.	$113.14 per sq. ft.	$1.10 per sq. ft.

Note: The general science room has only one workstation for the teacher's demonstrations. The laboratory has separate student workstations built in with gas lines, electricity, an emergency shower, a fume hood, and so forth.

As an aid in planning, it may be helpful to use the following estimates in terms of 1992 dollars to predict costs and plan for budgetary alternatives:

Architects' fees	12 to 15 percent of total
Inspection and tests	7 percent of total
Office of the State Architect, Structural Safety Section	.5 percent of total
Bid advertising/duplication	.5 percent of total
Contingency	10 percent of all listed on the next page

	Price range	*Average cost*
Basic building construction per laboratory/classroom	$75,000–115,000	$90,000
Plumbing per laboratory/classroom	17,000–26,000	22,000
Electrical per laboratory/classroom	4,000–15,000	7,000
Heating per laboratory/classroom	3,000–5,000	4,000
Heating and air conditioning per laboratory/classroom	0–10,000	(N/A)
Students' island, hexagonal, approximately 4 feet (1.2 m) diameter	2,600–4,000 each	3,200
Teacher's island, 2 feet x 2 feet (.6 m x .6 m)	900–1,200 each	1,000
*Display case, 2 x 4 x 7 feet (.6 x 1.2 x 2.1 m)	800–1,200 each	1,100
*Cabinet, storage, with shelves, 2 x 4 x 7 feet (.6 x 1.2 x 2.1 m)	600–1,000 each	900
*Fume hood, portable	1,500–2,000 each	1,600
**Chemicals storage cabinet, corrosive chemicals	500–1,500 each	800
**Chemicals storage cabinet, flammables	500–1,500 each	800
Base cabinets, (wall, peninsula 36 inches [91 cm] high x 27 to 30 inches [69 to 76 cm] deep)	180—190 per linear foot	
Over-counter wall cabinets (30 inches [76 cm] high x 12 to 15 inches [30 x 38 cm] deep)	70–80 per linear foot	

The costs shown in the preceding columns *do not* include classroom furniture (students' tables, chairs, teacher's desk, bookcases, portable demonstration table, and so forth), science equipment, or supplies for which parallel identification, budgeting, and procurement should be accomplished.

*Unless the district has difficulty in providing for the installation of these items itself, they preferably should not be included in the building contract so that payment of architects' and inspection fees can be avoided.

**Plans for local construction of inexpensive cabinets for this purpose appear in the *Science Safety Handbook for California High Schools.*

NOTES

Introduction

[1]*Science Framework for California Public Schools, Kindergarten Through Grade Twelve.* Sacramento: California Department of Education, 1990, p. 160.

[2]Ibid., p. 163.

[3]*Conditions for Good Science Teaching.* Edited by Victor M. Showalter. Washington, D.C.: National Science Teachers Association, 1984, p. 3. Reproduced by permission from *Conditions for Good Science Teaching,* © 1984 by the National Science Teachers Association.

[4]*Science Framework for California Public Schools, Kindergarten Through Grade Twelve.* Sacramento: California Department of Education, 1990, p. 9.

[5]Ibid., p. 178.

Chapter I. Enhancing Science Programs Through Architectural Design

[1]*Science Education for the 1980s: A Planning and Assessment Handbook for Kindergarten Through Grade Twelve.* Sacramento: California Department of Education, 1985, p. 19.

[2]Ibid., p. 21.

[3]*Conditions for Good Science Teaching.* Edited by Victor M. Showalter. Washington, D.C.: National Science Teachers Association, 1984, p. 4. Reproduced by permission from *Conditions for Good Science Teaching,* © 1984 by the National Science Teachers Association.

[4]Ibid., p. 5.

[5]Ibid., p. 6.

Chapter II. Architectural Requirements and Regulations

[1]*Remodeling and Building Science Instruction Facilities in Elementary, Middle, Junior, and Senior High Schools.* A Joint Project of Los Angeles, Orange, and San Diego County Offices of Education. San Diego: San Diego County Office of Education, n.d., p. 10.

[2]*Uniform Building Code,* Chapter 33, Table 33-A. Whittier, Calif.: International Conference of Building Officials, 1988.

[3]*Science Safety Handbook for California High Schools.* Sacramento: California Department of Education, 1987, p. 34.

[4]*Science Safety Handbook for California High Schools.* Sacramento: California Department of Education, 1987, p. 96.

[5]Ibid., p. 97.

[6]*Conditions for Good Science Teaching.* Edited by Victor M. Showalter. Washington, D.C.: National Science Teachers Association, 1984, p. 4. Reproduced by permission from *Conditions for Good Science Teaching,* © 1984 by the National Science Teachers Association.

[7]Ibid., p. 17.

[8]*Science Safety Handbook for California High Schools.* Sacramento: California Department of Education, 1987, p. 2.

Chapter III. Steps in the Planning Process

[1]*Remodeling and Building Science Instruction Facilities in Elementary, Middle, Junior, and*

Senior High Schools. A Joint Project of Los Angeles, Orange, and San Diego County Offices of Education. San Diego: San Diego County Office of Education, n.d., pp. 16–17.

Chapter IV. Elementary School Science Facilities

[1]*Science Framework for California Public Schools, Kindergarten Through Grade Twelve.* Sacramento: California Department of Education, 1990, p. 160.

[2]Ibid., p. 161.

Chapter V. Middle School Science Facilities

[1]*Science Framework for California Public Schools, Kindergarten Through Grade Twelve.* Sacramento: California Department of Education, 1990, p. 162.

[2]Ibid.

Chapter VI. High School Science Facilities

[1]*Science Framework for California Public Schools, Kindergarten Through Grade Twelve.* Sacramento: California Department of Education, 1990, p. 163.

[2]Ibid.

[3]Ibid., p. 166.

[4]Ibid.

[5]*Remodeling and Building Science Instruction Facilities in Elementary, Middle, Junior, and Senior High Schools.* A Joint Project of Los Angeles, Orange, and San Diego County Offices of Education. San Diego: San Diego County Office of Education, n.d., p. 7.

[6]Ibid.

[7]Ibid.

[8]Ibid.

Chapter VII. The Science Complex—From Site to Development to Occupancy

[1]*Remodeling and Building Science Instruction Facilities in Elementary, Middle, Junior, and Senior High Schools.* A Joint Project of Los Angeles, Orange, and San Diego County Offices of Education. San Diego: San Diego County Office of Education, n.d., p. 16.

[2]*Conditions for Good Science Teaching.* Edited by Victor M. Showalter. Washington, D.C.: National Science Teachers Association, 1984, p. 17. Reproduced by permission from *Conditions for Good Science Teaching,* © 1984 by the National Science Teachers Association.

[3]*Remodeling and Building Science Instruction Facilities in Elementary, Middle, Junior, and Senior High Schools.* A Joint Project of Los Angeles, Orange, and San Diego County Offices of Education. San Diego: San Diego County Office of Education, n.d., p. 16.

[4]Ibid.

[5]Ibid.

Chapter VIII. Furnishings and Appliances

[1]*Conditions for Good Science Teaching.* Edited by Victor M. Showalter. Washington, D.C.: National Science Teachers Association, 1984, p. 5. Reproduced by permission from *Conditions for Good Science Teaching,* © 1984 by the National Science Teachers Association.

[2]*1989 Catalog/Reference Manual.* Batavia, Ill.: Flynn Scientific, Inc., 1989, p. 385.

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APPENDIX A

Plan for the Total Science Complex

This checklist is designed to help you plan your new science facilities. Some items probably will not be applicable to your design. Duplicate the forms as needed for each room planned.

_____
(School)

_____
(Name of planner)

_____
(Name of administrator in charge [AIC])

_____ ( )
(Address of site) *(AIC's telephone number)*

_____
(Space/Budgetary allowance for science facilities)

_____
(Today's date) *(Anticipated completion date)*

Science Facilities Planning Committee Members

_____
(Name)

_____ ( )
(Address) *(Telephone number)*

_____
(Name)

_____ ( )
(Address) *(Telephone number)*

_____
(Name)

_____ ( )
(Address) *(Telephone number)*

_____
(Name)

_____ ( )
(Address) *(Telephone number)*

_____
(Name)

_____ ( )
(Address) *(Telephone number)*

_____
(Name)

_____ ( )
(Address) *(Telephone number)*

Plan for the Total Science Complex (Continued)

Anticipated enrollment	Opening	Year two	Year three	Peak
Grade five				
Grade six				
Grade seven				
Grade eight				
Grade nine				
Grade ten				
Grade eleven				
Grade twelve				
Totals				

Enrollment of science courses to be taught	Opening	Number of classes	Peak	Number of classes
Middle School/Junior High School				
Earth/Space science				
Life science				
Physical Science				
Other				
Other				
Senior High School				
Biology/Life science				
Chemistry				
Earth/Space science				
Physical science				
Physics				
Physiology				
Other				
Other				
Other				
Totals				
Number of science laboratory/ classrooms needed				

Site assets favorable for science (Check if present or nearby.):

- ☐ Institutions of higher learning
- ☐ Marine areas
- ☐ Native rocks
- ☐ Native vegetation
- ☐ Rivers
- ☐ Science-related industries
- ☐ Soils
- ☐ Wildlife preserves
- ☐ Woods
- ☐ Other natural areas

Other (Specify.):

- ☐ _____
- ☐ _____
- ☐ _____

Plan for the Total Science Complex (Concluded)

List briefly the improvements that any of the items checked previously will bring to the science program.

_____

_____

_____

Would a specific location for science facilities and/or the development of specific curriculum materials be desirable?

_____

_____

_____

Will the life sciences program justify:

A greenhouse?	☐ Yes ☐ No
An environmental study chamber for plants?	☐ Yes ☐ No
An environmental study chamber for animals?	☐ Yes ☐ No
An outdoor environmental study area?	☐ Yes ☐ No
A room for plants or animals or both?	☐ Yes ☐ No

Will the kind and amount of hazardous chemicals used justify a separate:

Chemical storage area?	☐ Yes ☐ No
Hazardous waste storage area?	☐ Yes ☐ No
Will the curriculum justify a darkroom for science?	☐ Yes ☐ No
Should a central preparation/storage area accessible from *all* science rooms be provided?	☐ Yes ☐ No
Are cooperative programs with other subject areas planned?	☐ Yes ☐ No

(If yes, specify.) _____

Should the teaching facilities provide:

Separate rooms for laboratory and nonlaboratory activities?	☐ Yes ☐ No
Combined rooms for laboratory and nonlaboratory activities?	☐ Yes ☐ No
A large-group lecture facility?	☐ Yes ☐ No
Special facilities for an anticipated innovative teaching plan?	☐ Yes ☐ No

Describe: _____

_____

Using graph paper, prepare a rough sketch of the science facilities in a configuration that would best accommodate the responses given previously.

APPENDIX B

Laboratory/Classroom Checklist

This checklist is designed to help you plan your new science facilities. Some items probably will not be applicable to your design. Duplicate the forms as needed for each room planned. You might wish to work simultaneously on the scale diagram suggested at the end of this appendix as you complete the preliminary part of the appendix. A rough estimate of the costs may later be calculated by applying the information in Chapter IX.

School: _____ Room: _____

Subject: _____

Room Arrangement:

- ☐ Perimeter
- ☐ Island
- ☐ Peninsula (Four-student)
- ☐ Peninsula (Eight-student)
- ☐ Peninsula (Twelve-student)
- ☐ Other (Specify.)_____

Room area: Desired dimensions: _____ ft. x _____ ft. = _____ sq. ft.

or _____ m x _____ m = _____ m^2

Counter space (perimeter): (Linear feet or meters): Suggested 20 to 80 lin. ft. (6 to 24 lin. m), depending on choices shown under "Room Arrangement"
Perimeter counters = _____ ft. or m

Cabinets, base: (Linear feet or meters): Suggested 20 to 80 lin. ft. (6 to 24 lin. m), depending on choices shown under "Room Arrangement"
Base cabinets = _____ ft. or m

Cabinets, wall: (Linear feet or meters): Suggested 20 to 80 lin. ft. (6 to 24 lin. m)
Wall cabinets = _____ ft. or m

Sinks, number of: Suggested 5 to 9, depending on choices shown under "Room Arrangement"
Total number of sinks = _____

Electrical outlets, number of: (Duplex) Suggested 15 to 24 (Adjust if plug mould is used.)
Total number of outlets = _____

Gas jets, number of: Suggested 12 to 18
Total number of gas jets = _____

Islands (Twelve-student)	(Suggested 0, 2, or 3)	Total = _____
Peninsulas (Four-student)	(Suggested 0 or 6 to 9)	Total = _____
Peninsulas (Eight-student)	(Suggested 0 or 3 to 5)	Total = _____
Peninsulas (Twelve-student)	(Suggested 0, 2, or 3)	Total = _____
Other (Specify.): _____		Total = _____

Island, teacher's: 2 ft. x 2 ft. (.6 m x .6 m) ☐ yes ☐ no
or ___ x ___ ___ m x ___ m ☐ yes ☐ no

Demonstration table, (fixed) _____ x _____ ☐ yes ☐ no

Whiteboard: (Linear feet or meters) Suggested 10 to 30 lin. ft. (3 to 9 lin. m) = _____ linear ft. or m

Tackboard: (Linear feet or meters) Suggested 5 to 15 lin. ft. (2 to 5 lin. m) = _____ linear ft. or m

Cabinet, storage: 2 ft. x 4 ft. x 7 ft. (.6 m x 1.2 m x 2.1 m) Total = _____
☐ Number of: _____

Display case: 2 ft. x 4 ft. x 7 ft. (.6 m x 1.2 m x 2.1 m) Total = _____
☐ Number of: _____

Fire extinguisher: Number of _____ Fire blanket: Number of _____
Type(s)_____

Cleanup sink: ☐ Yes ☐ No Dimensions: _____ x _____

Fume hood: ☐ Yes ☐ No

Number of exits: _____ Smoke/Heat detector: Number of _____

Master Control:

Electrical	☐ Yes	☐ No
Gas	☐ Yes	☐ No
Water	☐ Yes	☐ No

Other Considerations:

Adequate ventilation	☐ Yes	☐ No	
Blindspots in classroom	☐ Yes	☐ No	
Deluge shower	☐ Yes	☐ No	☐ N/A
Eyewash station	☐ Yes	☐ No	
Handicapped station	☐ Yes	☐ No	
Purge system	☐ Yes	☐ No	☐ N/A
Separate air conditioning	☐ Yes	☐ No	☐ N/A

Locations of and Provisions for the Following:

- ☐ Access to preparation or storage area
- ☐ Access to project or conference area
- ☐ Audiovisual networking
- ☐ Audiovisual room darkening
- ☐ Bookcase
- ☐ Computer probeware
- ☐ First-aid kit
- ☐ Goggles sanitizer
- ☐ Handicapped access
- ☐ Microscope storage
- ☐ Networking computers
- ☐ Precision balances
- ☐ Other:_____

Comments

Sketch a scale diagram of the laboratory/classroom in both the laboratory and nonlaboratory modes. Be certain that adequate space is available for student activities; for example, allow 2.5 to 3 feet (.75 to .9 m) for aisles (The recommended distance to accommodate the disabled is 3 feet [.9 m].); 5 feet (1.5 m) front to back for seating at student tables; 3.5 feet (1.1 m) front to back for desk chairs; 5 feet (1.5 m) for a space where students will be working back to back in a laboratory mode, and so forth. Refer also to the allowances provided in "Space Allocations," which appears in Chapter II of this publication.

APPENDIX C

Science Preparation/Storage Area

This appendix is designed to help you plan your new science facilities. Some items probably will not be applicable to your design. Duplicate the forms as needed for each preparation/storage area planned. The following list and the scale diagram suggested at the end of this appendix should be completed together. Refer to the sketch on page 65.

School: _____ Room: _____

Subject(s) accommodated: _____

Area of room: Square feet or square meters desired _____
(Dimensions: _____ sq. ft. x _____ sq. ft. or _____ m^2 x _____ m^2)

Sinks: Number of _____ Electrical outlets: Number of _____

Hot water faucets: Number of _____ Gas outlets: Number of _____

Cold water faucets: Number of _____ Exits: Number of _____

Counter space: (Linear feet or meters) _____ ft. or m

Base cabinets: (Linear feet or meters) _____ ft. or m

Cabinets, overcounter: (Linear feet or meters) _____ ft. or m

Whiteboard: Number of _____ Dimensions _____ x _____ _____ ft. or m

Tackboard: Number of _____ Dimensions _____ x _____ _____ sq. ft. or m^2

Shelving, open: Height _____
Depth _____ _____ cu. ft. or m^3
Linear feet or meters _____

Checklist:

- ☐ Adequate ventilation
- ☐ Animal care facilities ☐ N/A
- ☐ Area free of ignition sources; for example, a gas-controlled water heater
- ☐ Corrosive chemical storage
- ☐ Earthquake lips
- ☐ Eyewash station
- ☐ Fan vent
- ☐ Fire blanket Number: _____
- ☐ Fire extinguisher Number: _____
  Type: _____ Number: _____
- ☐ First-aid kit
- ☐ Flammable liquid storage
- ☐ Fume hood ☐ N/A
- ☐ Goggles sanitizer
- ☐ Isolated ammonium nitrate storage

- ☐ Isolated nitric acid storage
- ☐ Isolated poisons storage
- ☐ Mobile chemical spill cart
- ☐ Planning or conference area for teachers
- ☐ Plant care facilities ☐ N/A
- ☐ Safety shower and drain ☐ N/A
- ☐ Separate air conditioning (if air conditioning is provided)
- ☐ Separate storage for metals
- ☐ Separate storage for oxidizers
- ☐ Shelving secured to wall
- ☐ Smoke/Heat detector Number of: _____
- ☐ Storage for gases, compressed, flammable
- ☐ Storage for gases, compressed, nonflammable
- ☐ Teacher-student conference area

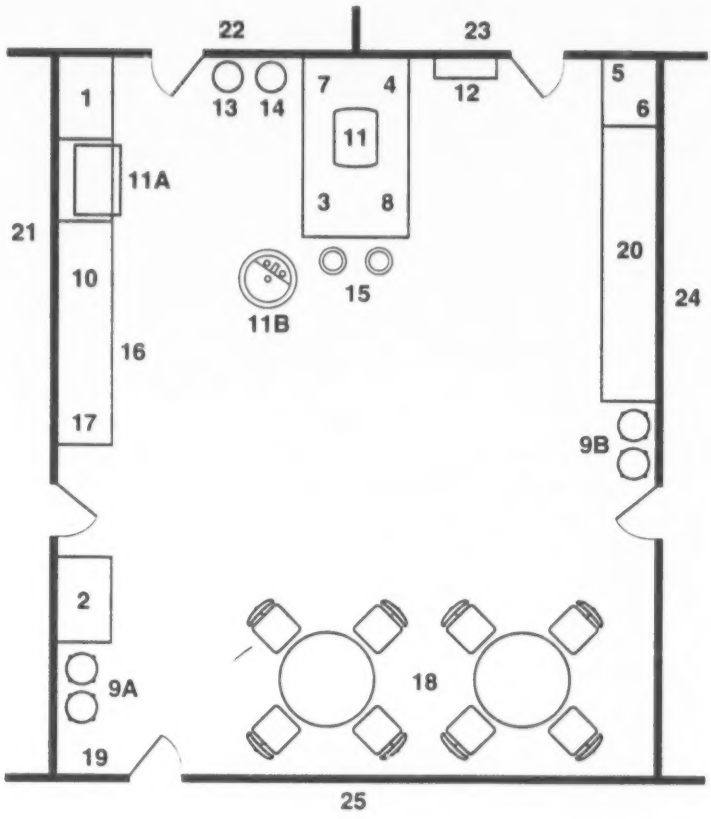
Locations and provisions have been made for:

- ☐ Bookcases
- ☐ Chemical waste receptacles
- ☐ Chemicals inventory (MSDS)
- ☐ Equipment/Models storage
- ☐ Filing cabinets
- ☐ Networking computers
- ☐ Refrigerator
- ☐ Other: _____

Sketch a scale diagram of the storage/preparation area. Be certain that adequate space has been allowed for aisles, tables, transit of demonstration and storage carts, chemicals, preparation of apparatus, and so forth. (See the *Science Safety Handbook for California High Schools* for additional specifications.)

Fig. 49. Diagram of a Preparation/Storage Area

From *Science Safety Handbook for California High Schools*. Sacramento: California Department of Education, 1987, p. 40.



1. Metals storage
2. Oxidizers storage
3. Ammonium nitrate storage
4. Bases cabinet } may be combined if necessary
5. Acids cabinet } and contain item 6 if isolated
6. Isolated nitric acid storage
7. Flammables cabinet
8. Poisons drawer

9A. Compressed gases—nonflammable/ oxidizing, chained or strapped to a wall

9B. Compressed gases—flammable, chained or strapped to a wall

10. Low-hazard chemicals storage with earthquake lips; secured to walls
11. Sink and counter with hot and cold water, gas, electricity, eyewash station, exhaust hood over, cabinet underneath

11A. Refrigerator

11B. Emergency shower

12. First-aid kit
13. ABC fire extinguisher
14. Fire blanket
15. Plastic waste receptacles
16. Chemical spill kit
17. Chemical inventory system, including material safety data sheets
18. Conference or preparation area
19. Emergency evacuation procedure
20. Apparatus/glassware storage cabinets secured to walls with earthquake lips

21–24. Adjacent classroom laboratories

25. Hall or outside exit; all doors self-closing and lockable

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